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Hamady

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(54) PRECESSIONAL DEVICE AND METHOD THEREOF

(76) Inventor: Peter Winston Hamady, 202 Riverside Dr., #7A, New York, NY (US) 10025

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(51) Int. Cl.^{7} G01C 19/02; A63B 23/14
(52) U.S. Cl. 74/5.34; 482/44
(58) Field of Search 74/5.34, 5.37; 482/44, 45, 110; 446/233, 235, 246

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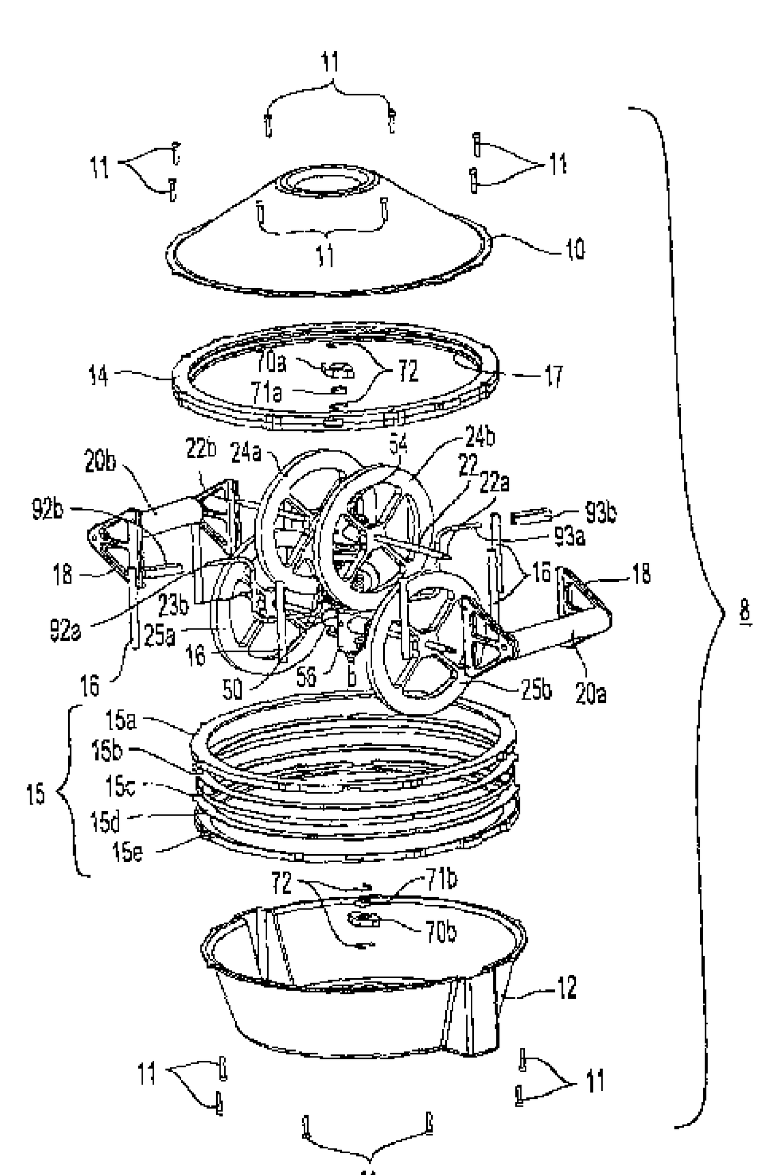
(57) ABSTRACT

A precessional device featuring a pair of axles each containing at least one flywheel forming a pair of rotors. The pair of axles are each mounted on circular track assemblies in which they rotate and generate a precessional torque that provides variable resistance along a first axis and a balancing of the precessional torque along a second axis.

53 Claims, 70 Drawing Sheets



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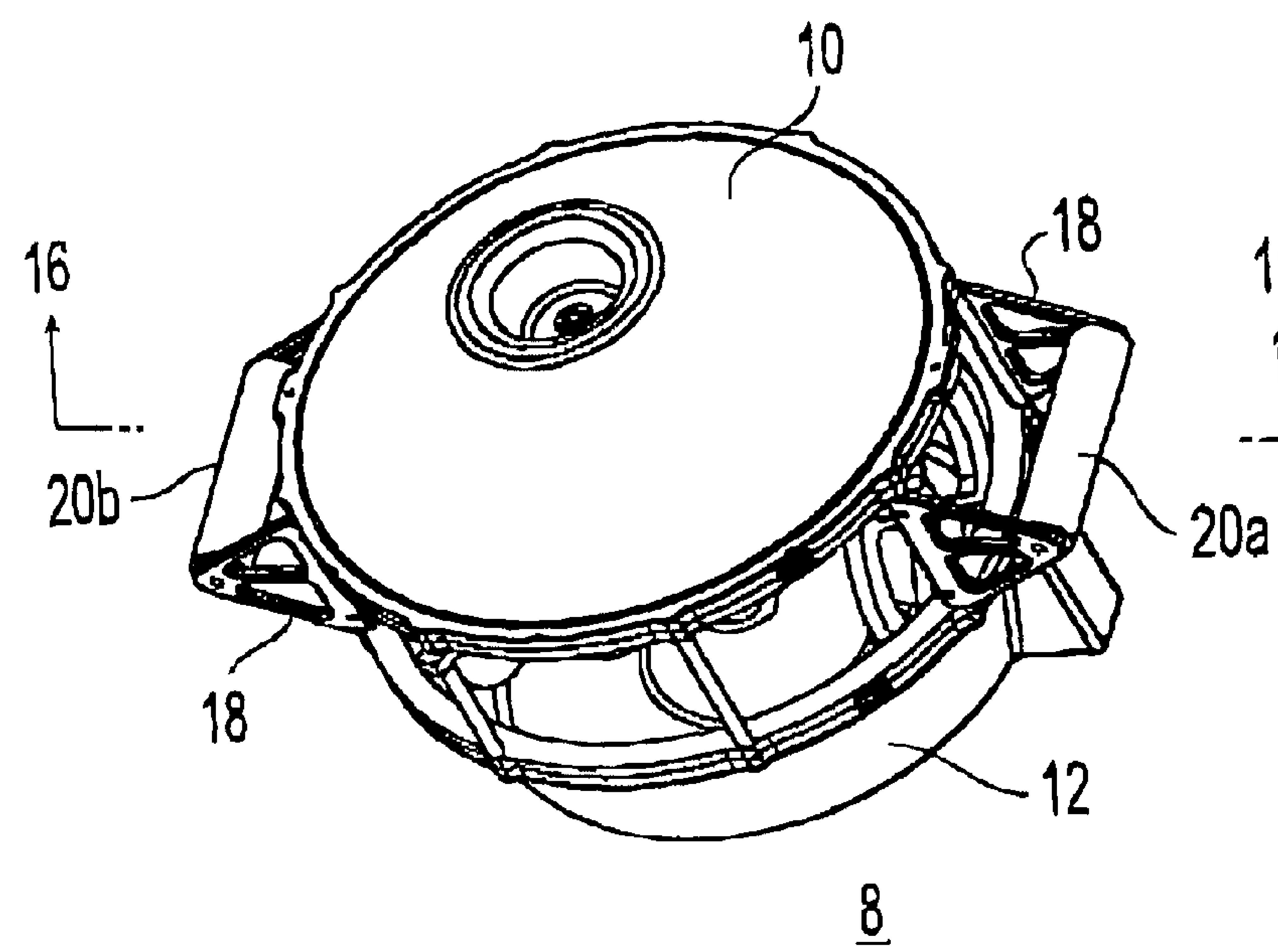

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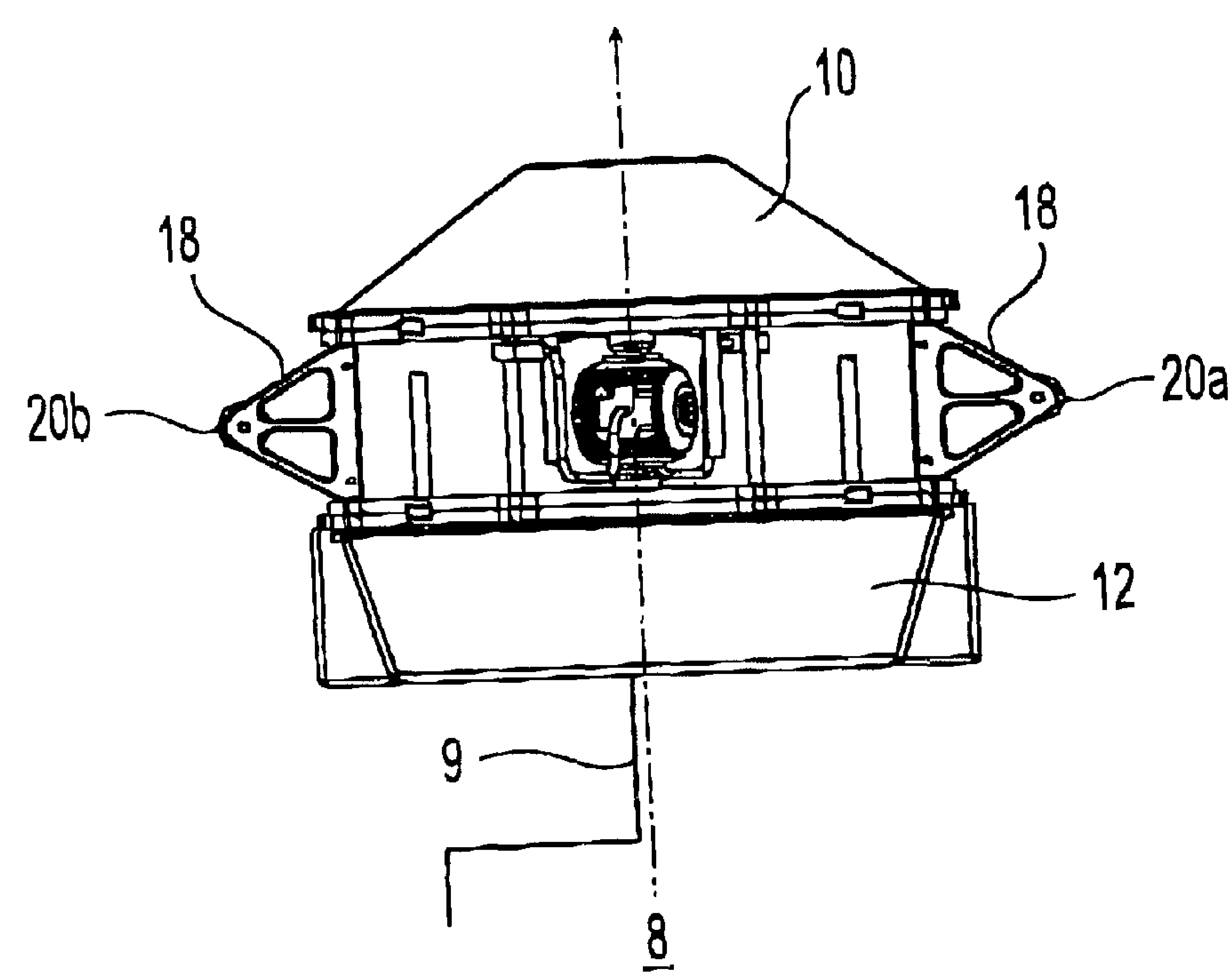

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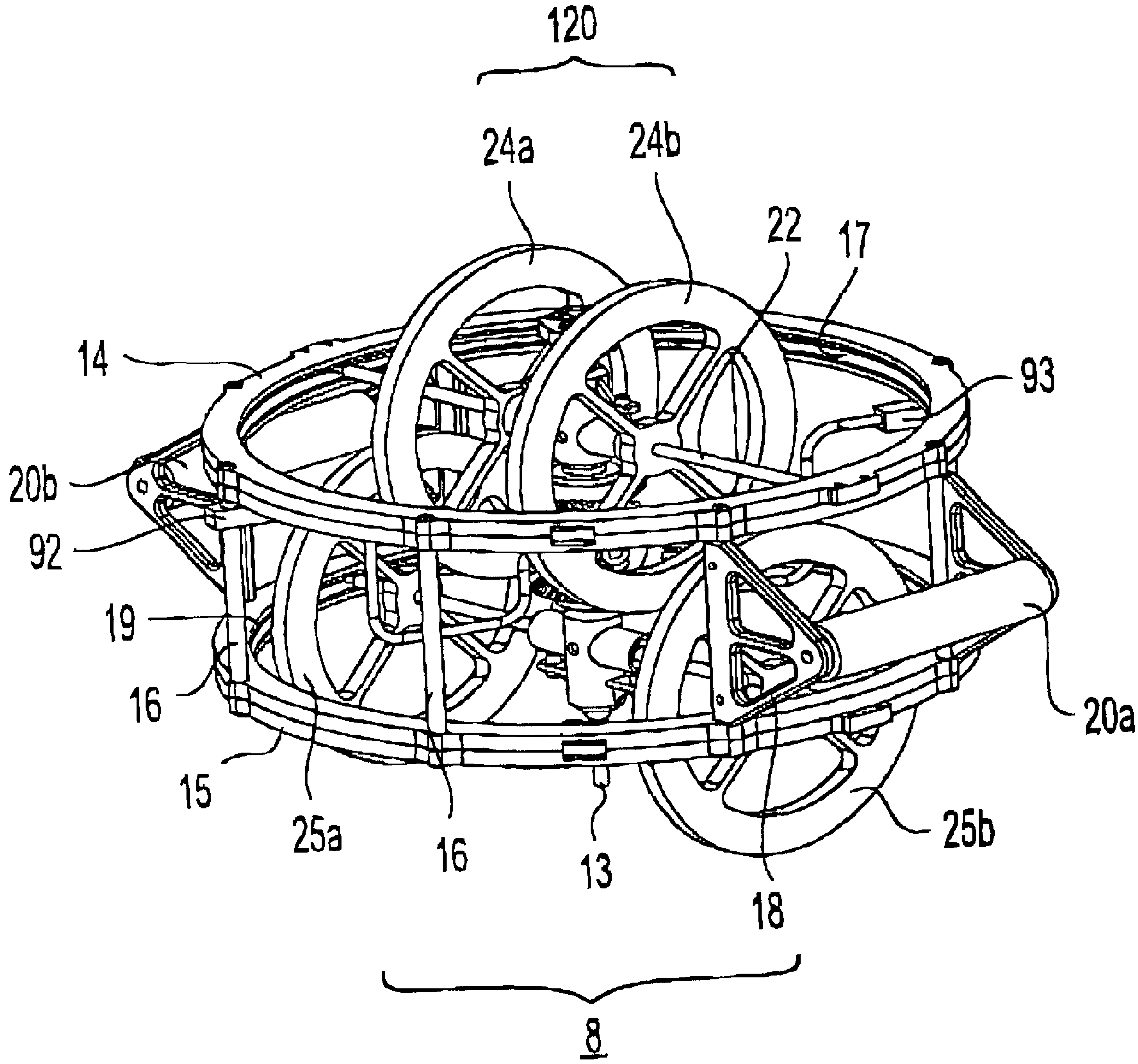

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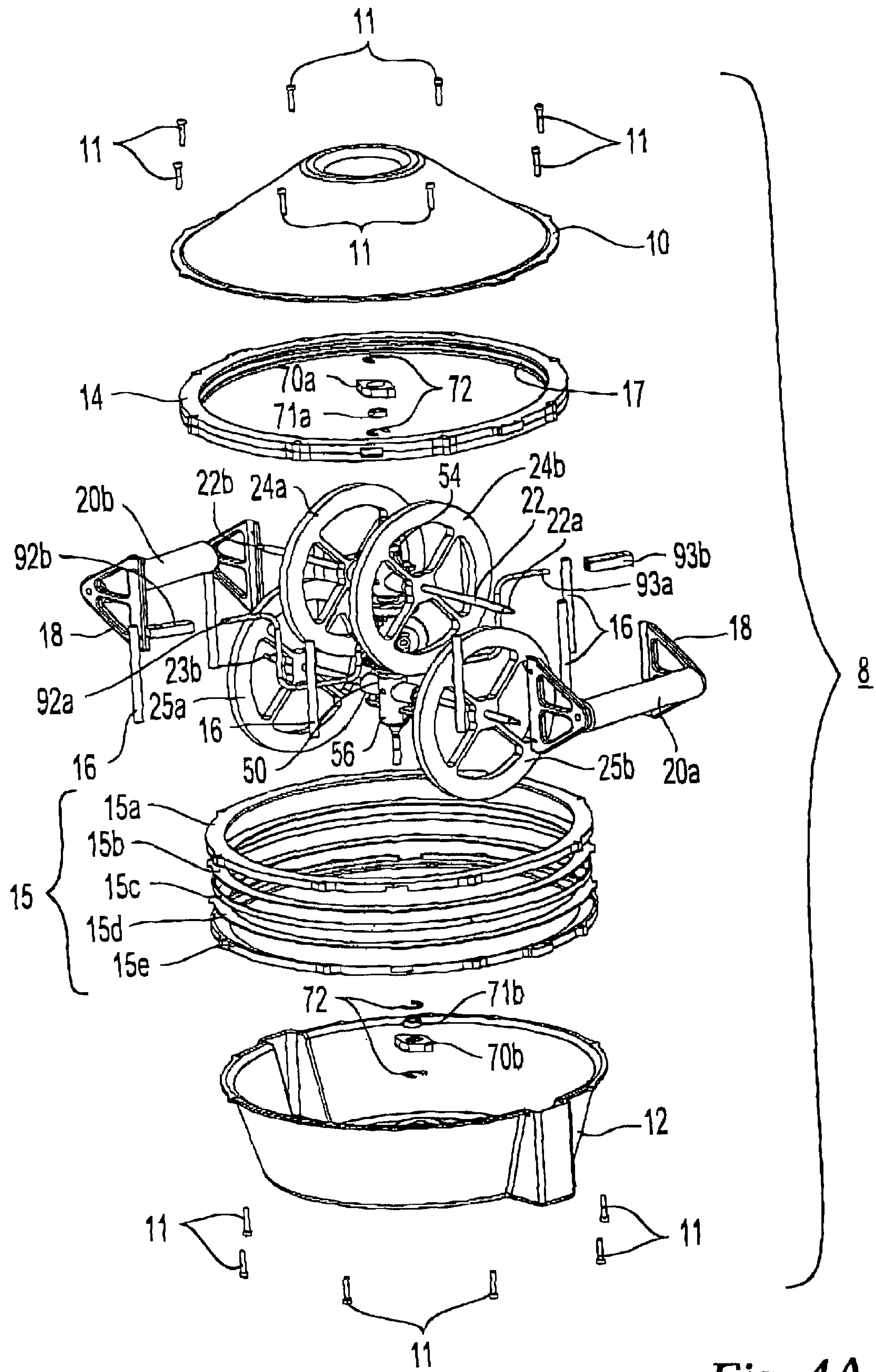
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Fig. 4A

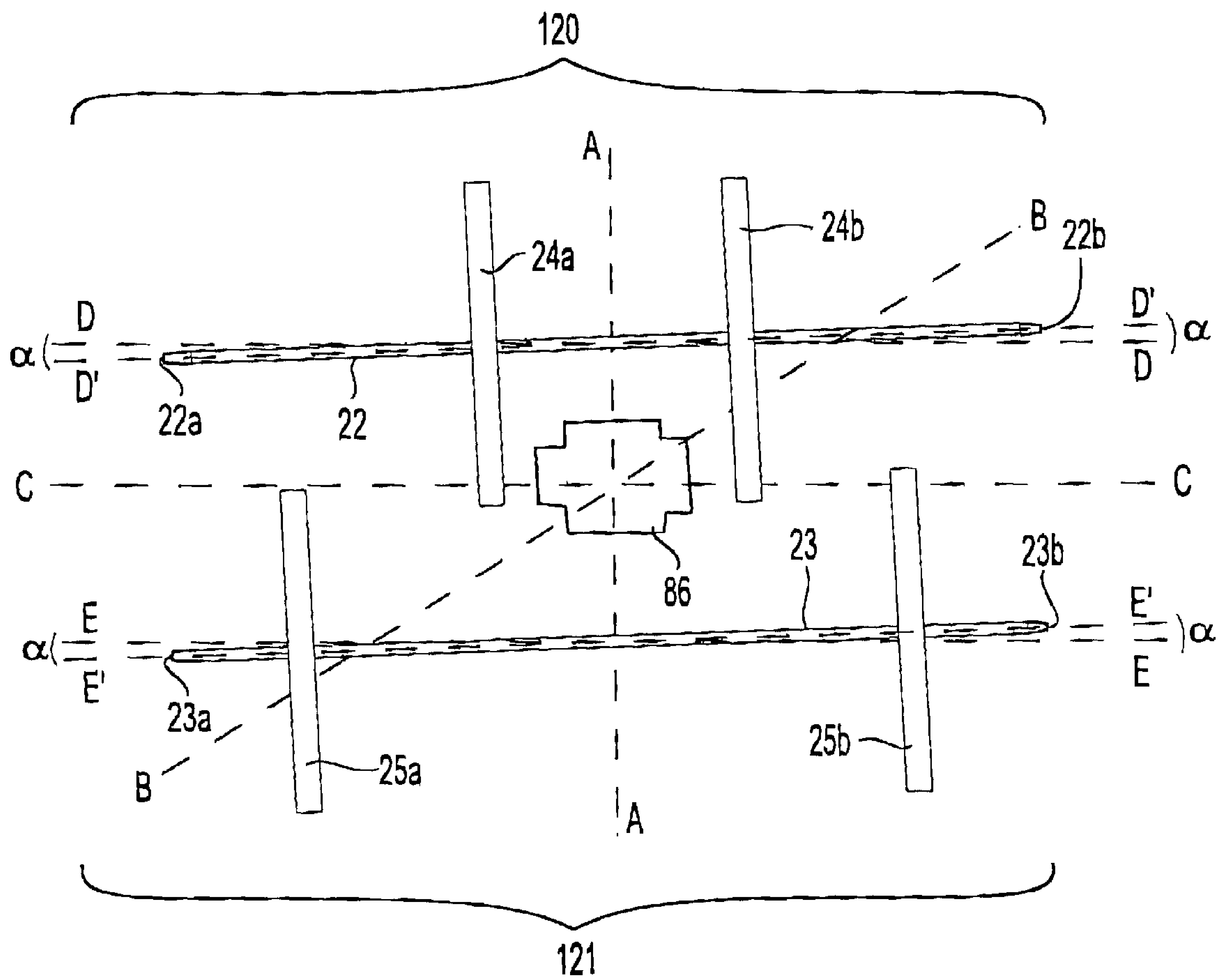
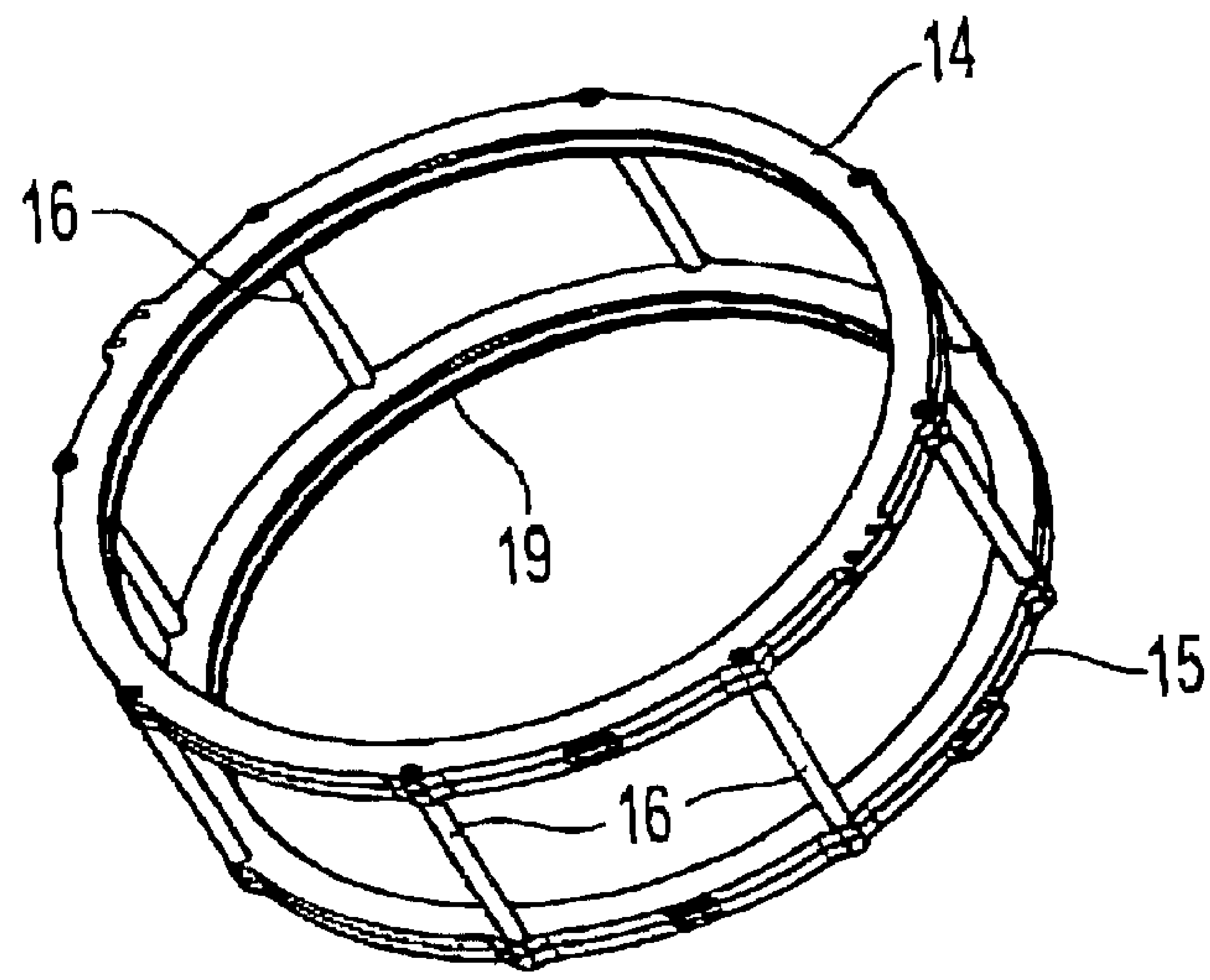


Fig. 4B



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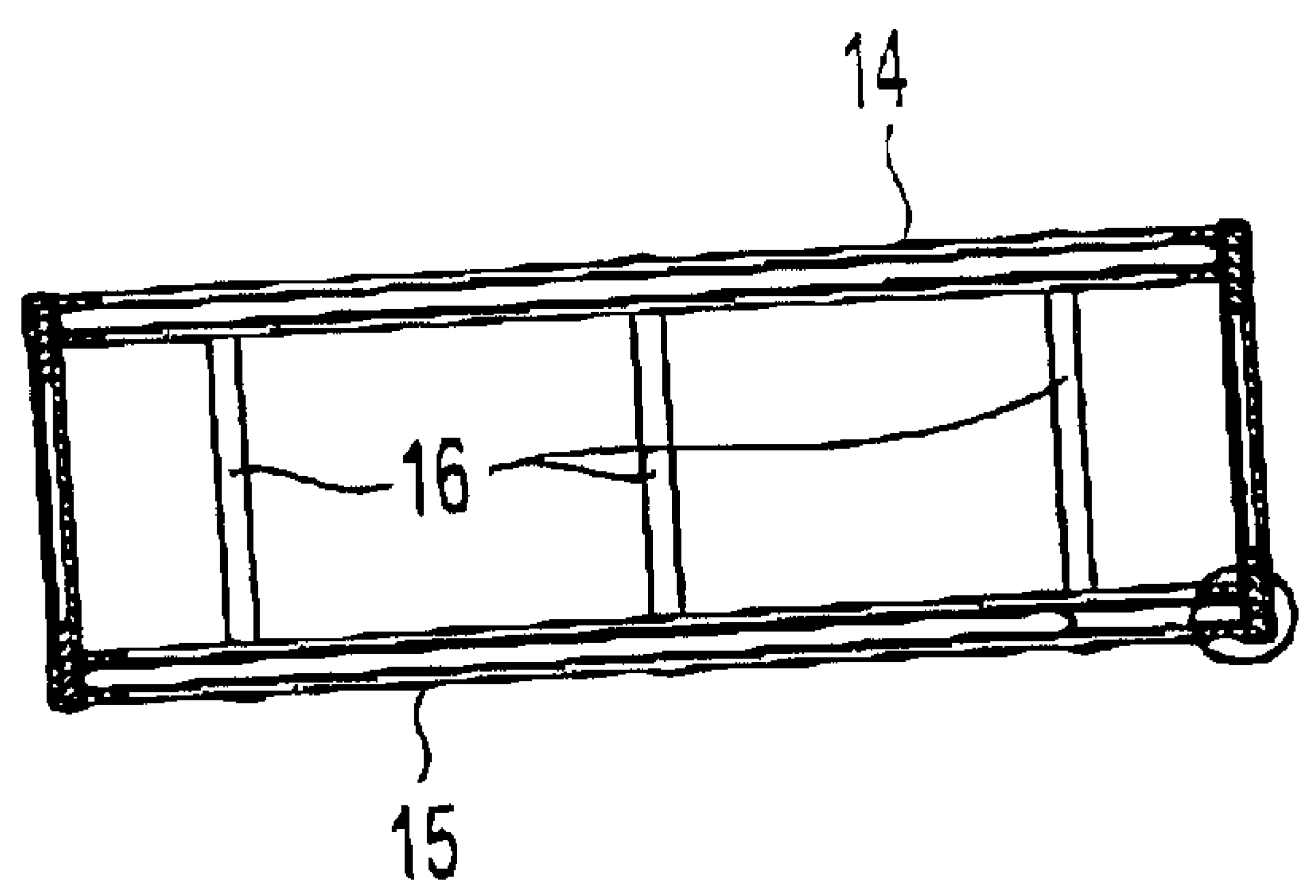

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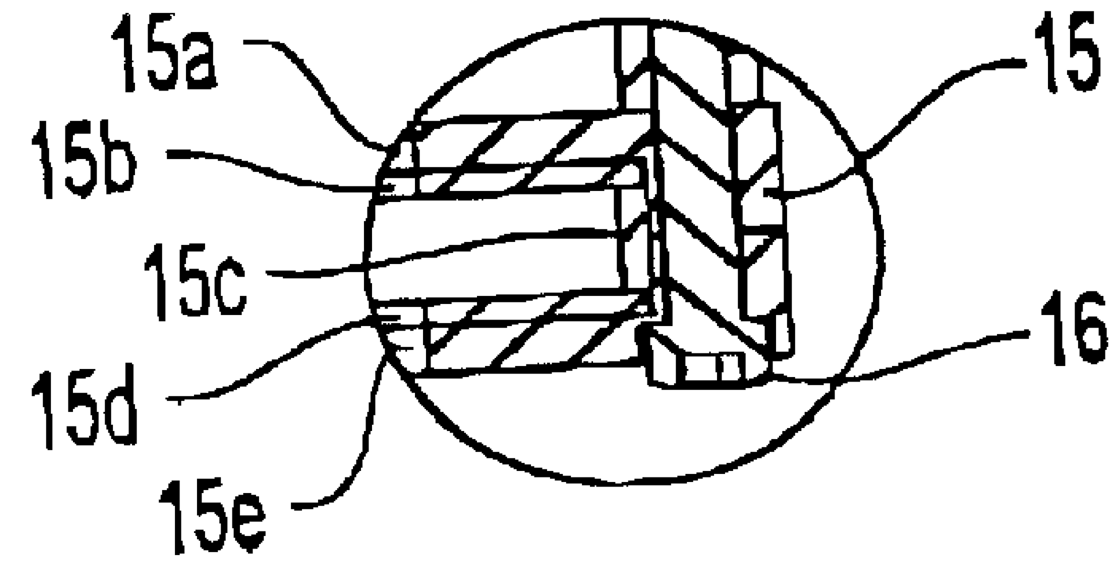

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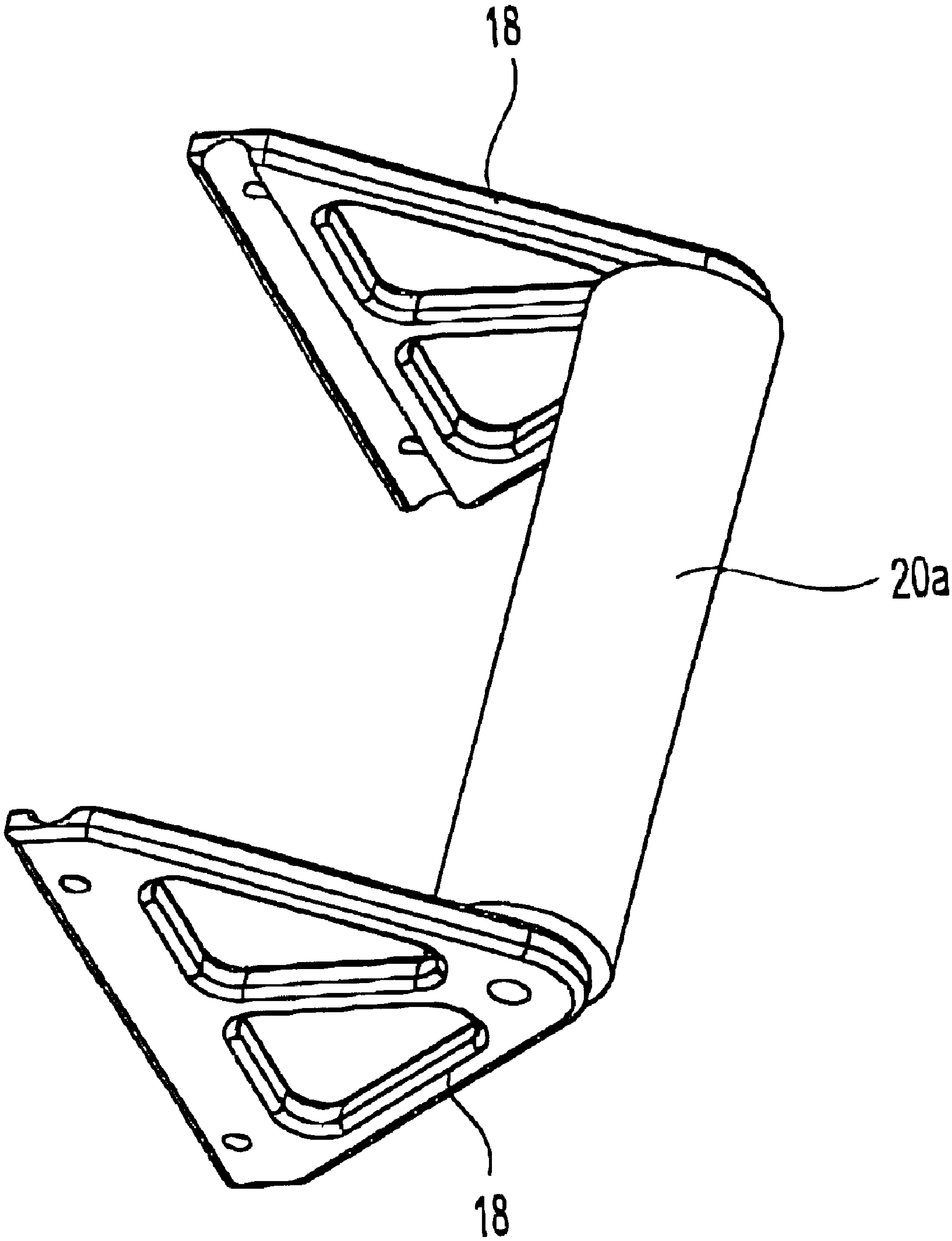

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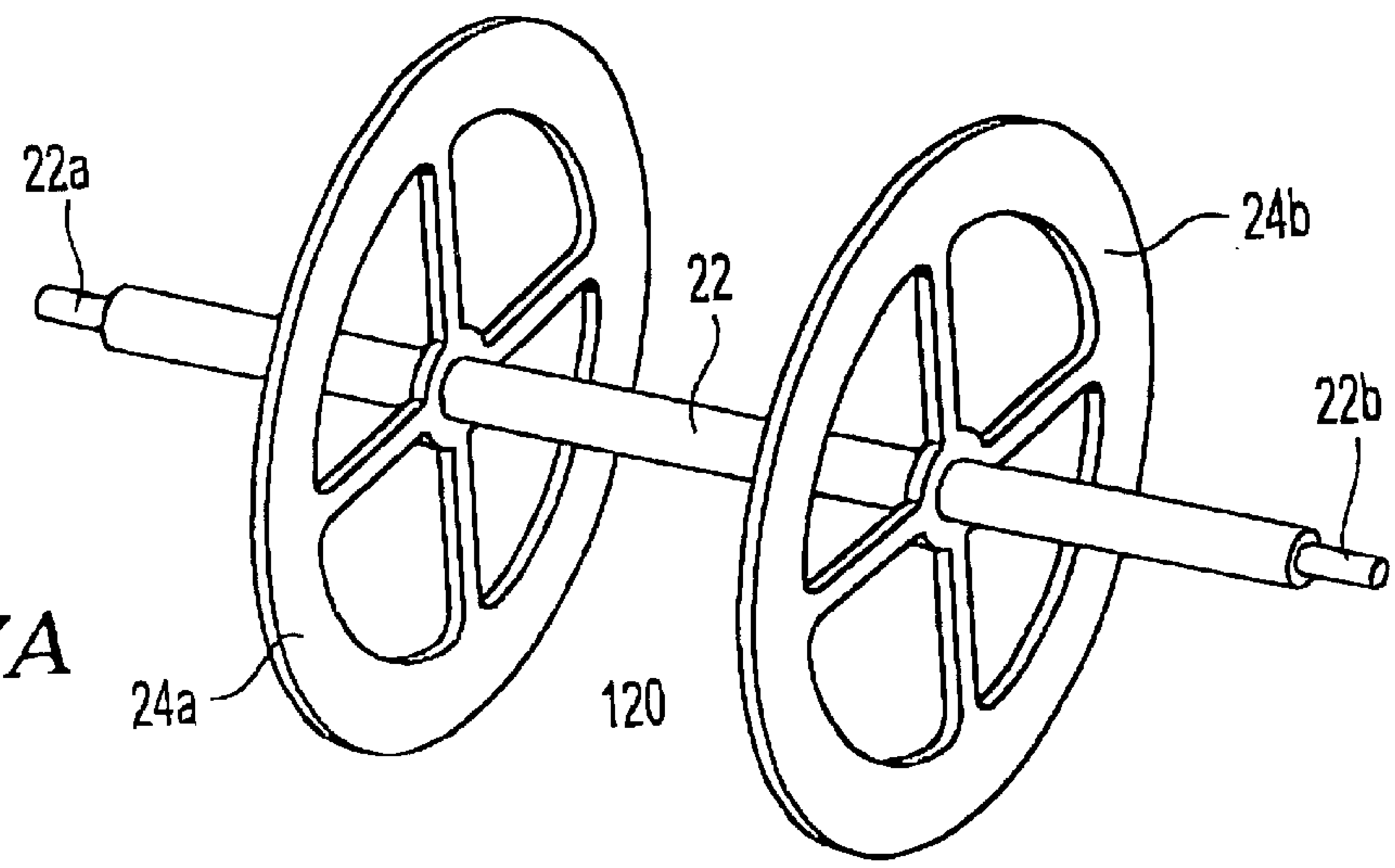

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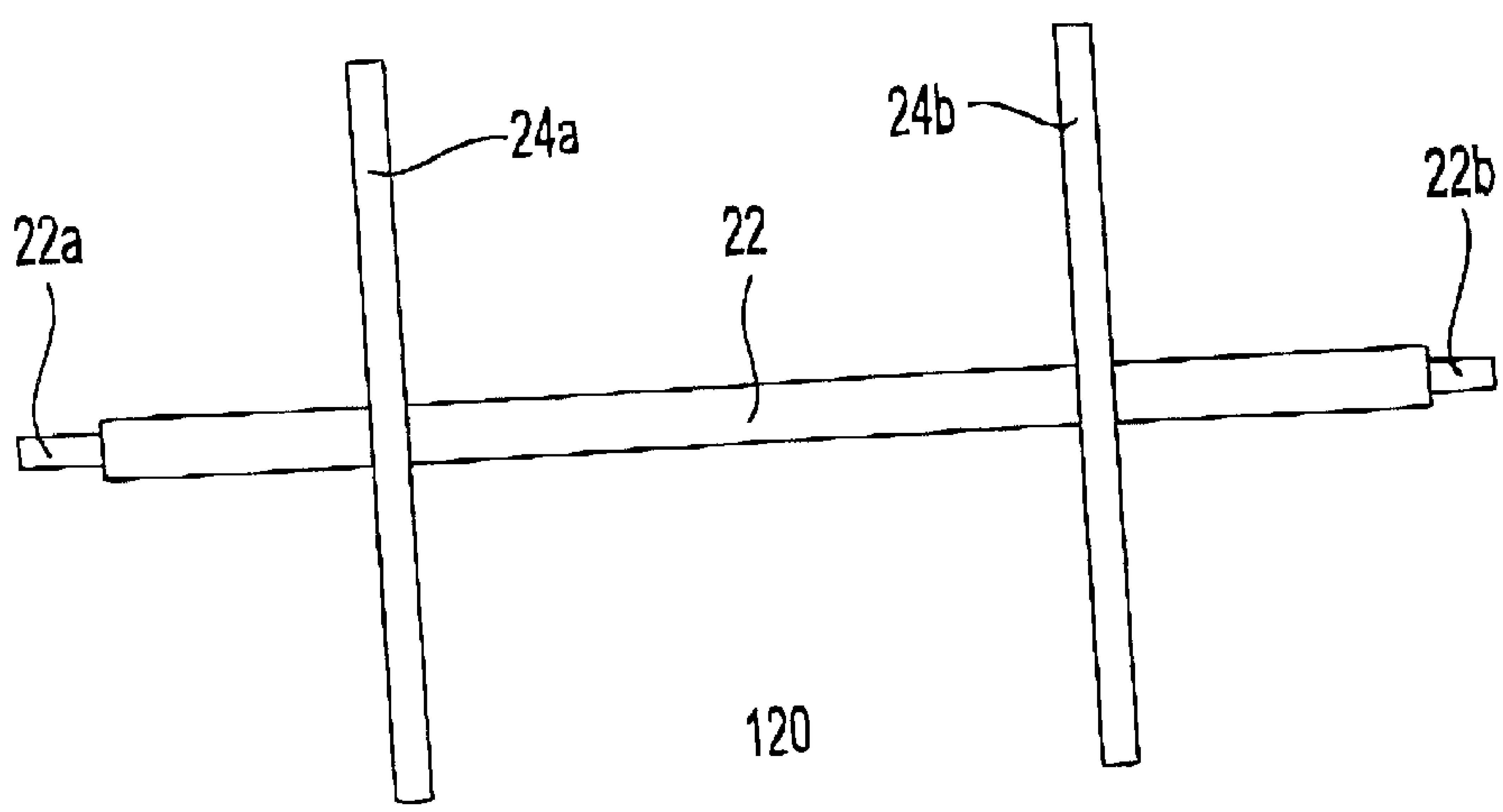

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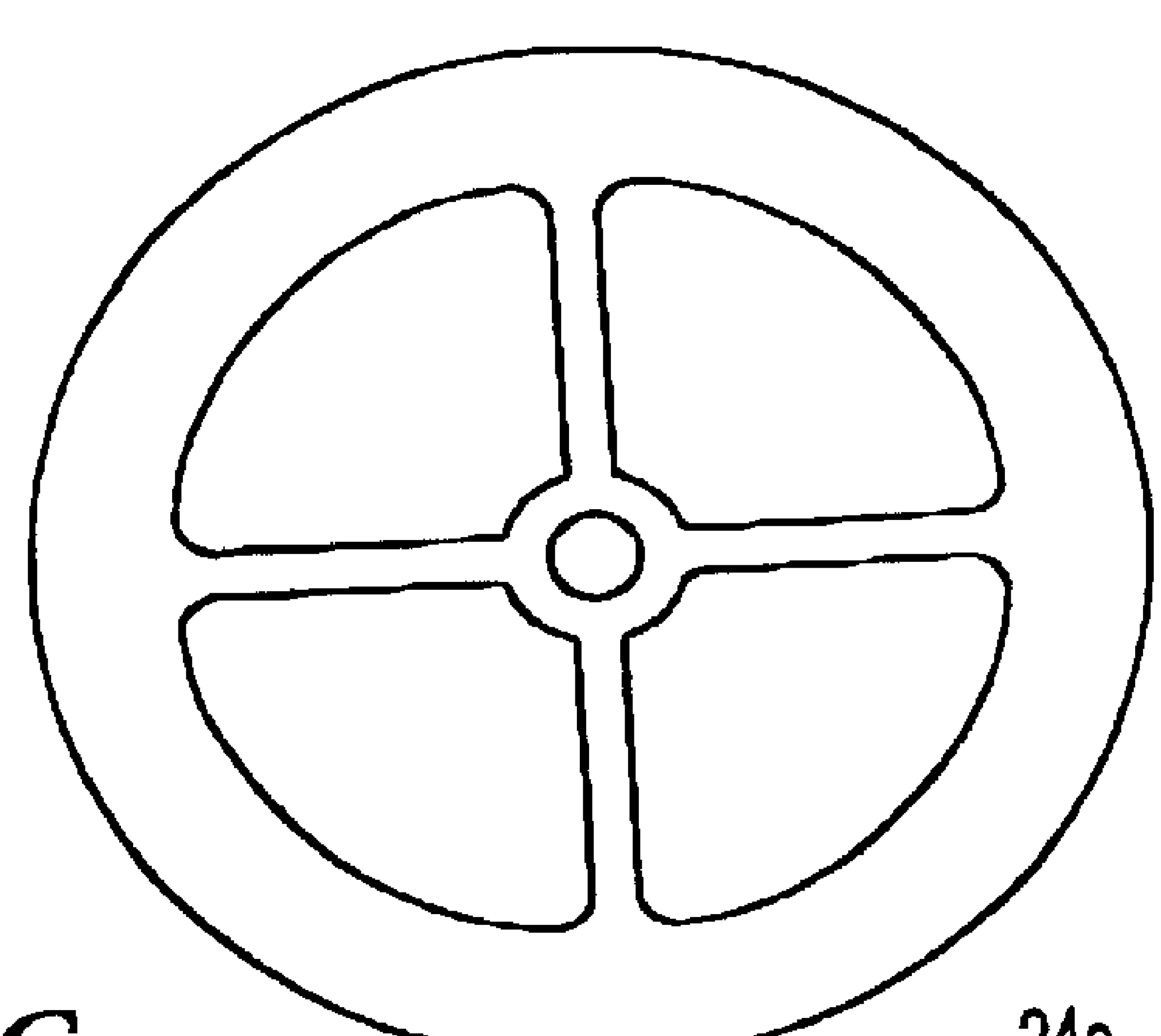

Fig. 7C

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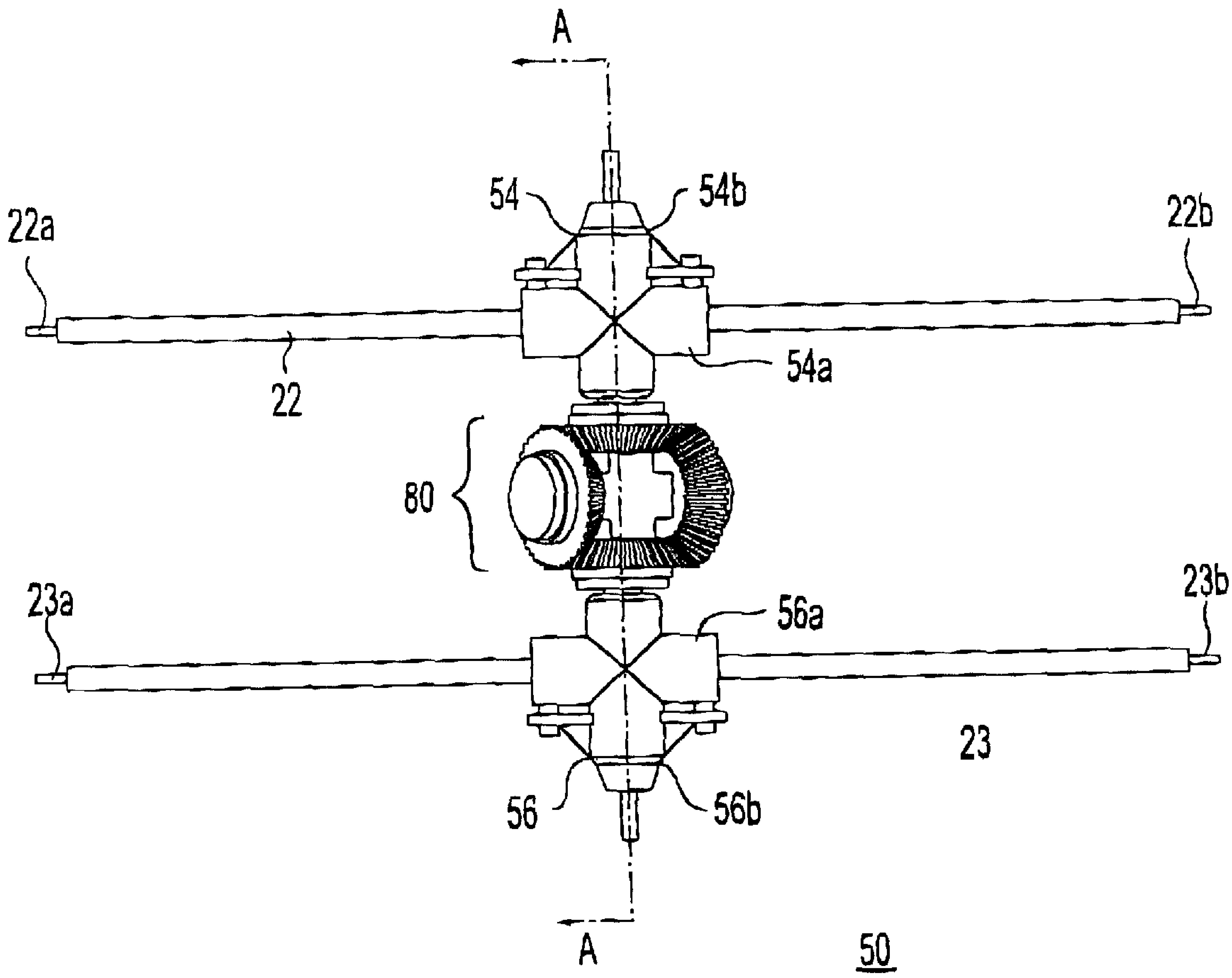

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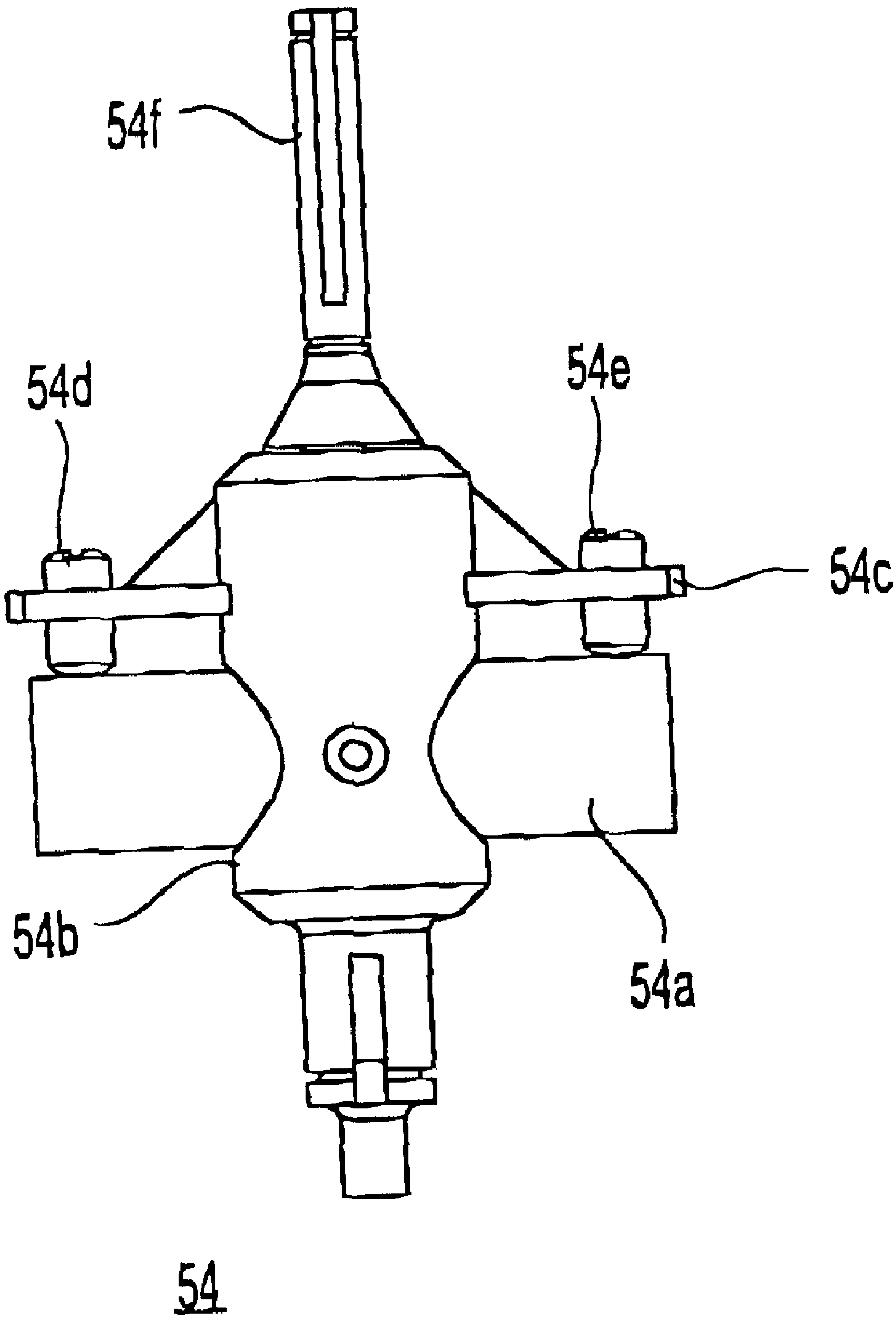

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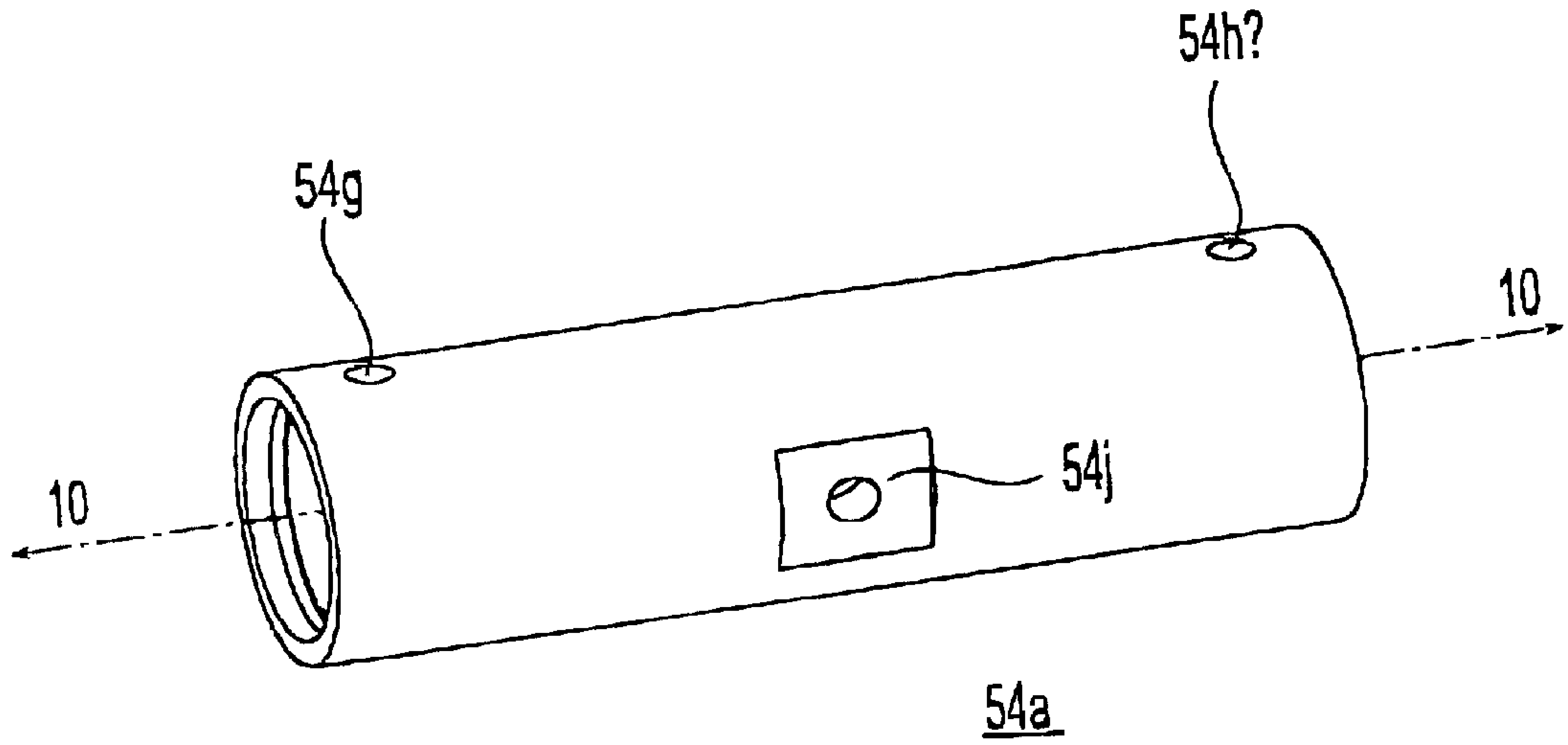

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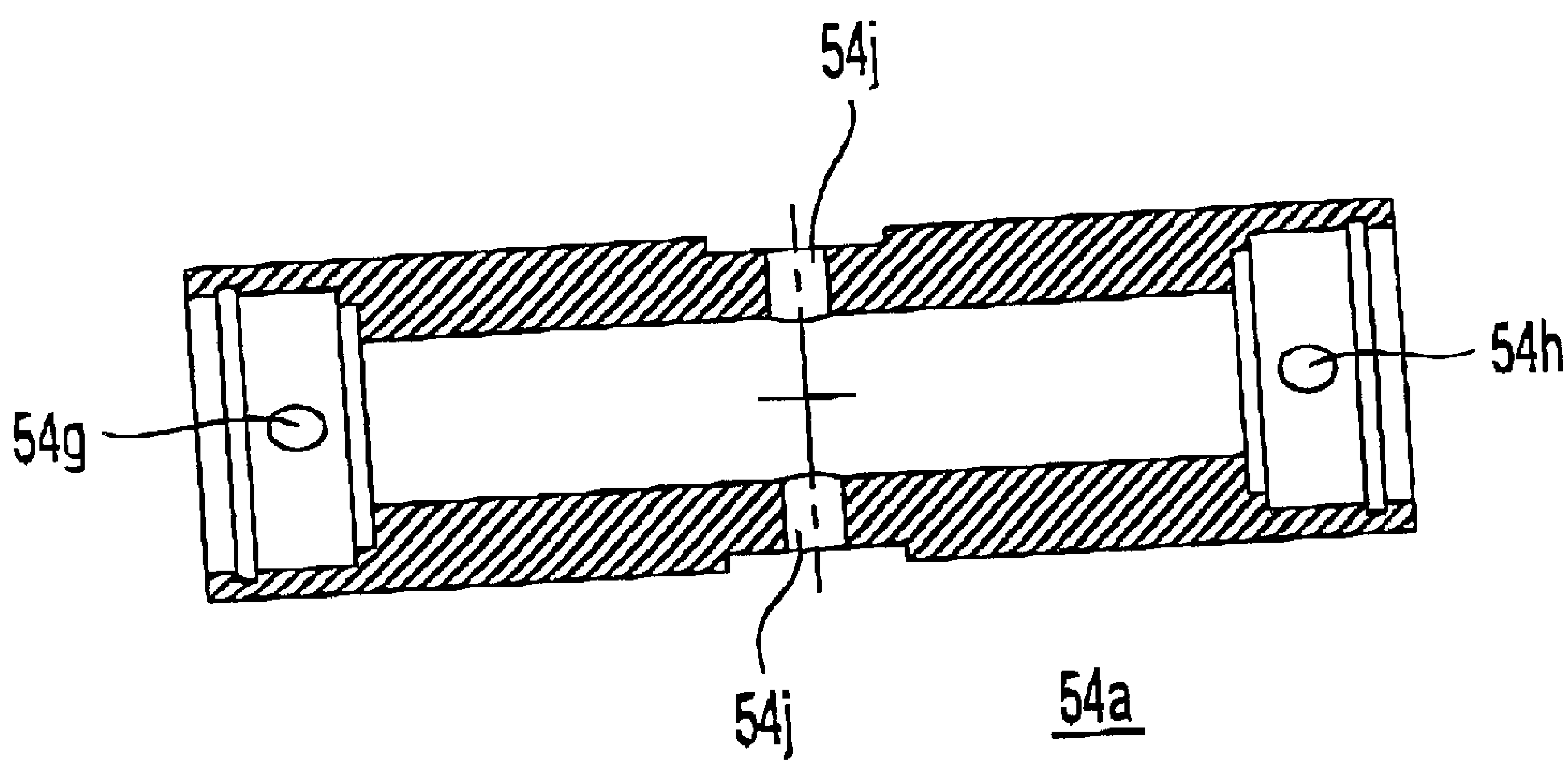

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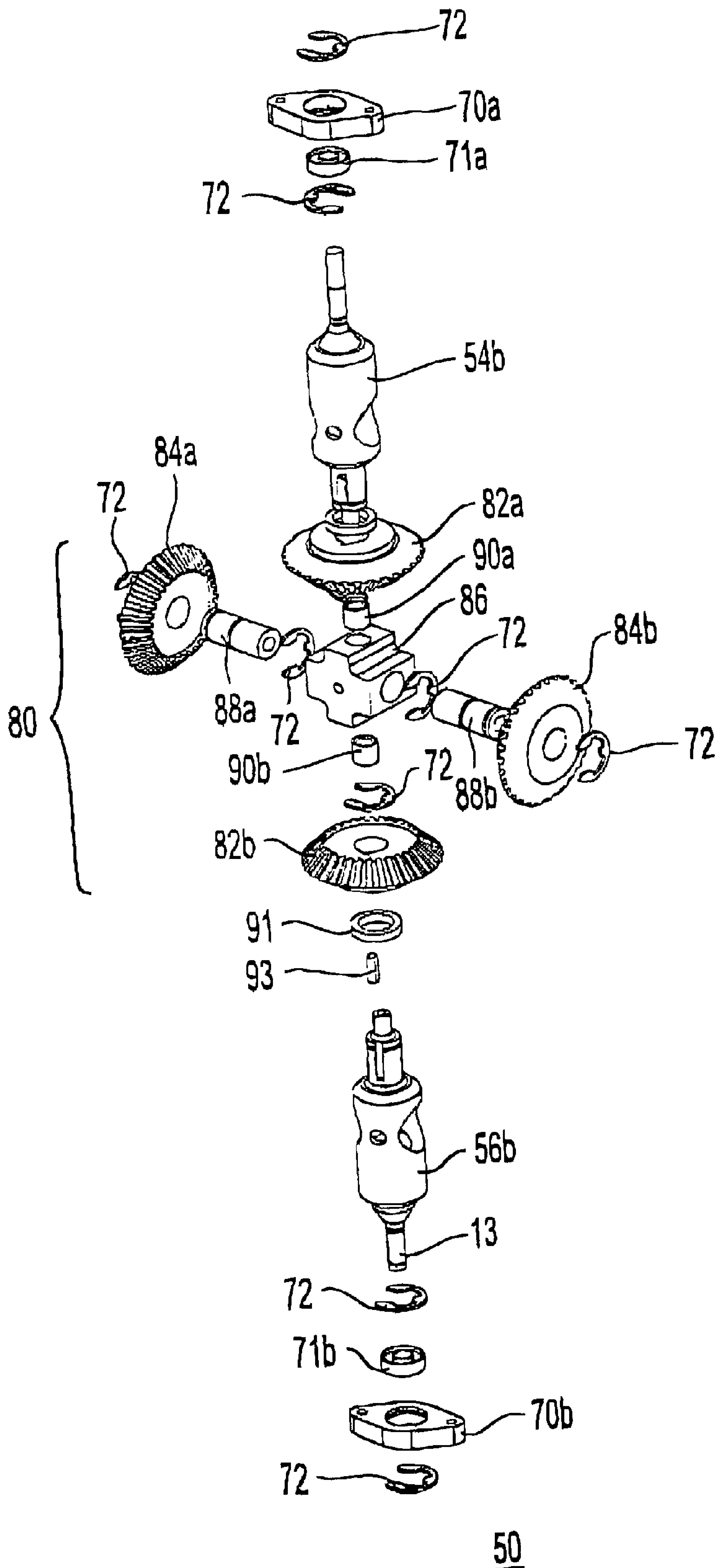
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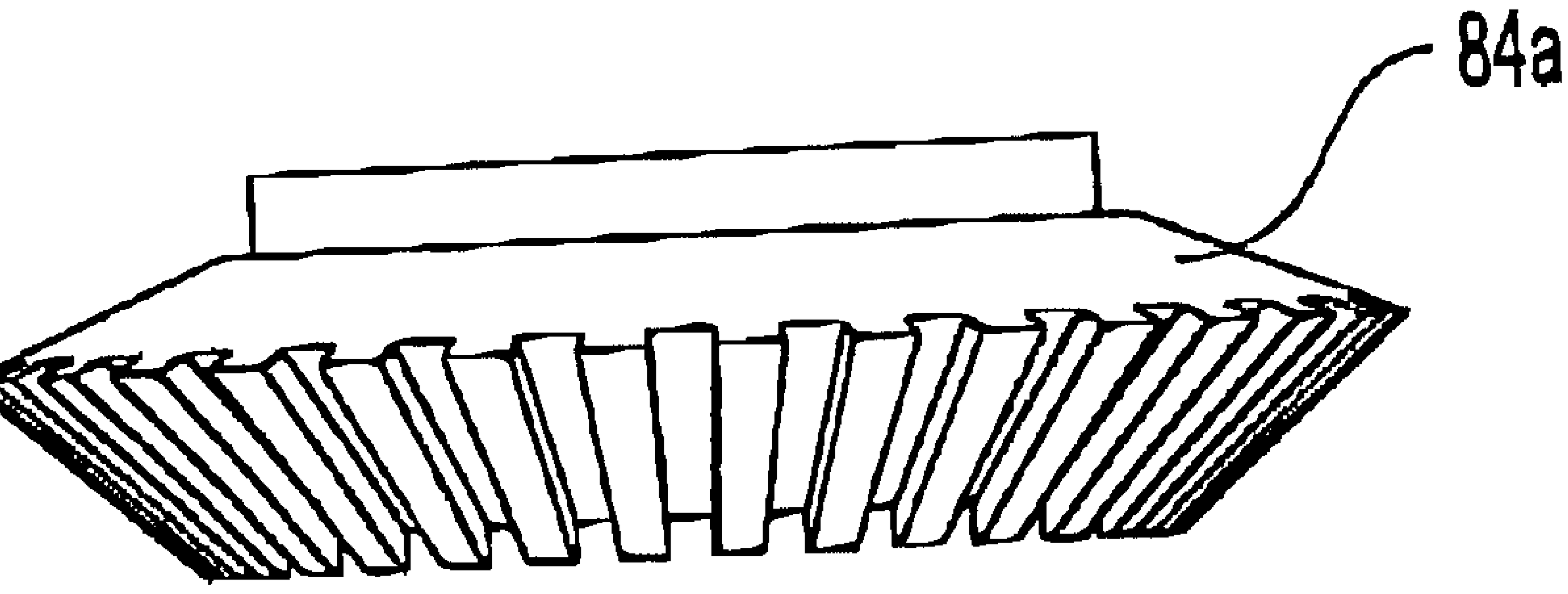
Fig. 11



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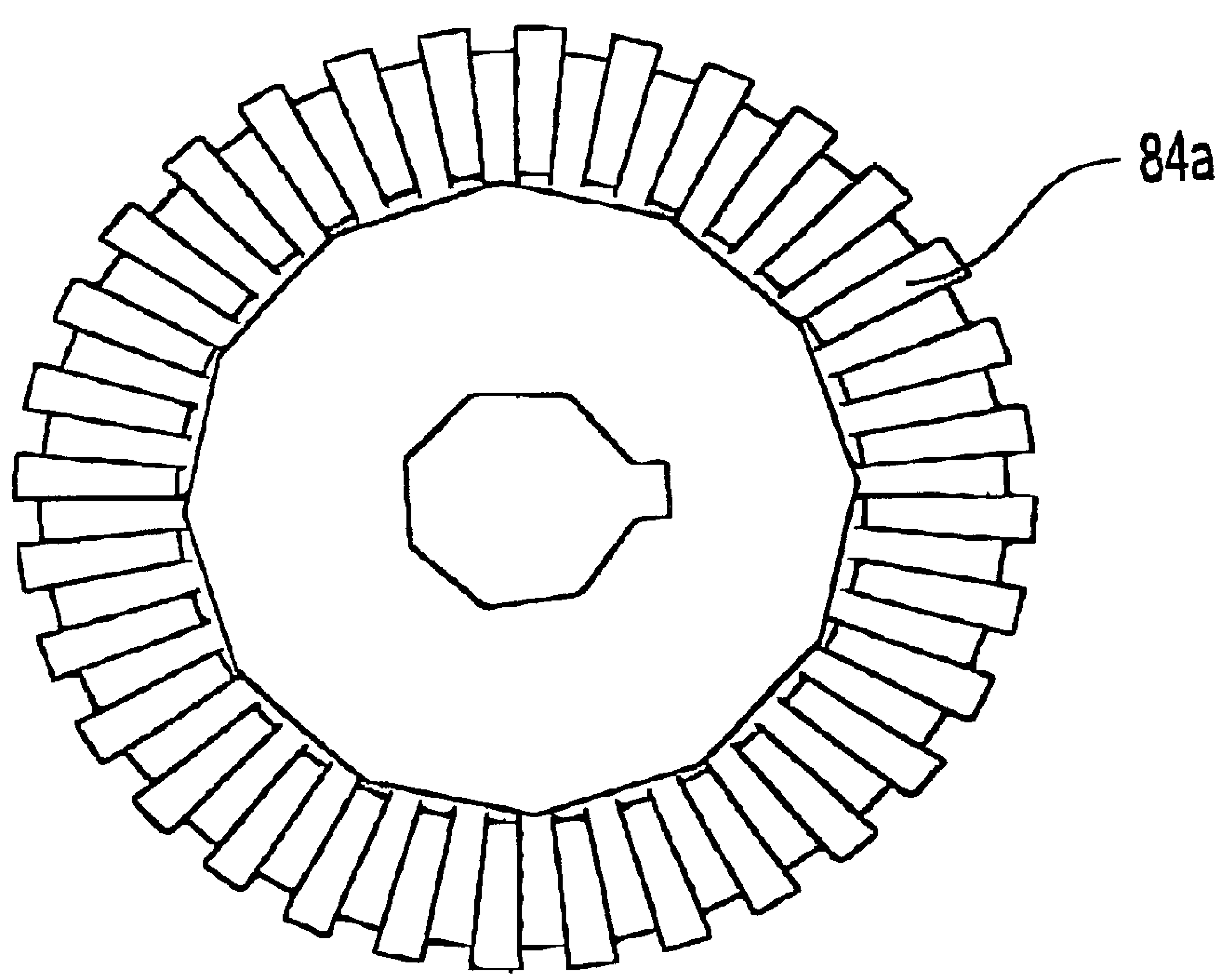

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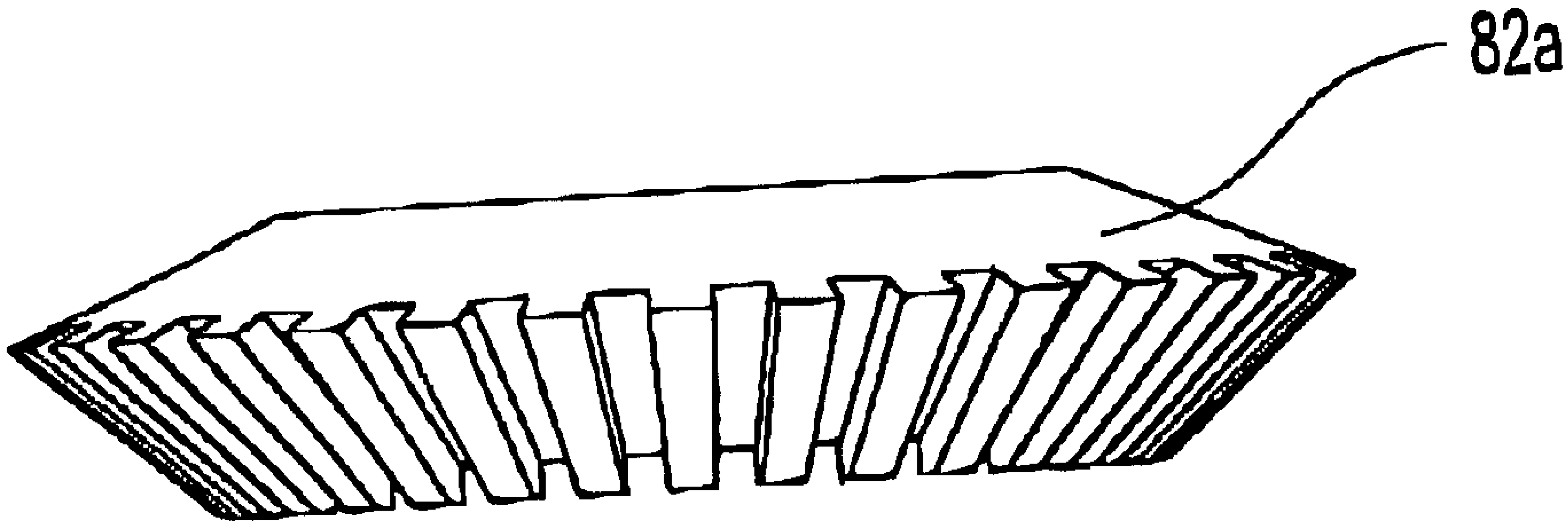

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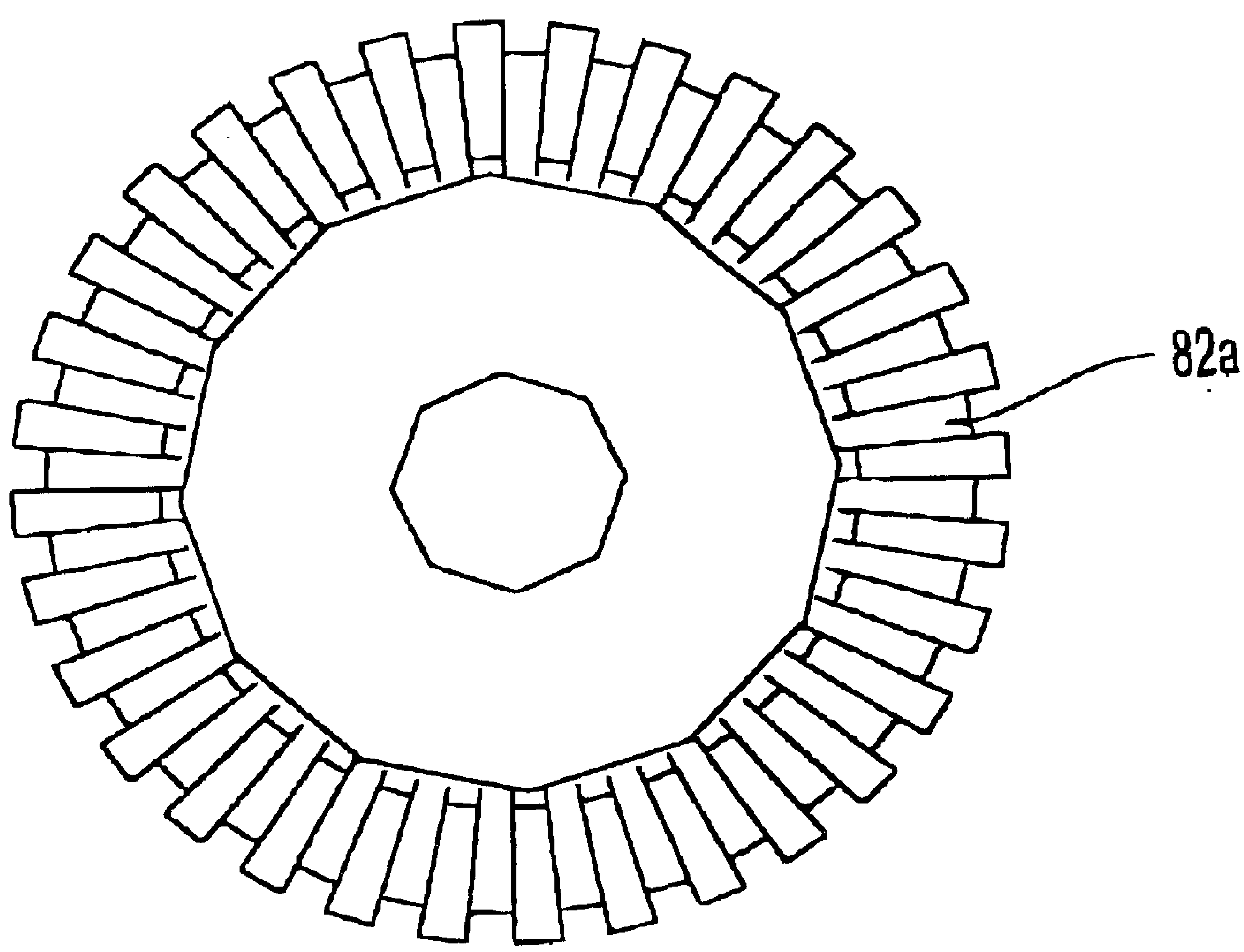

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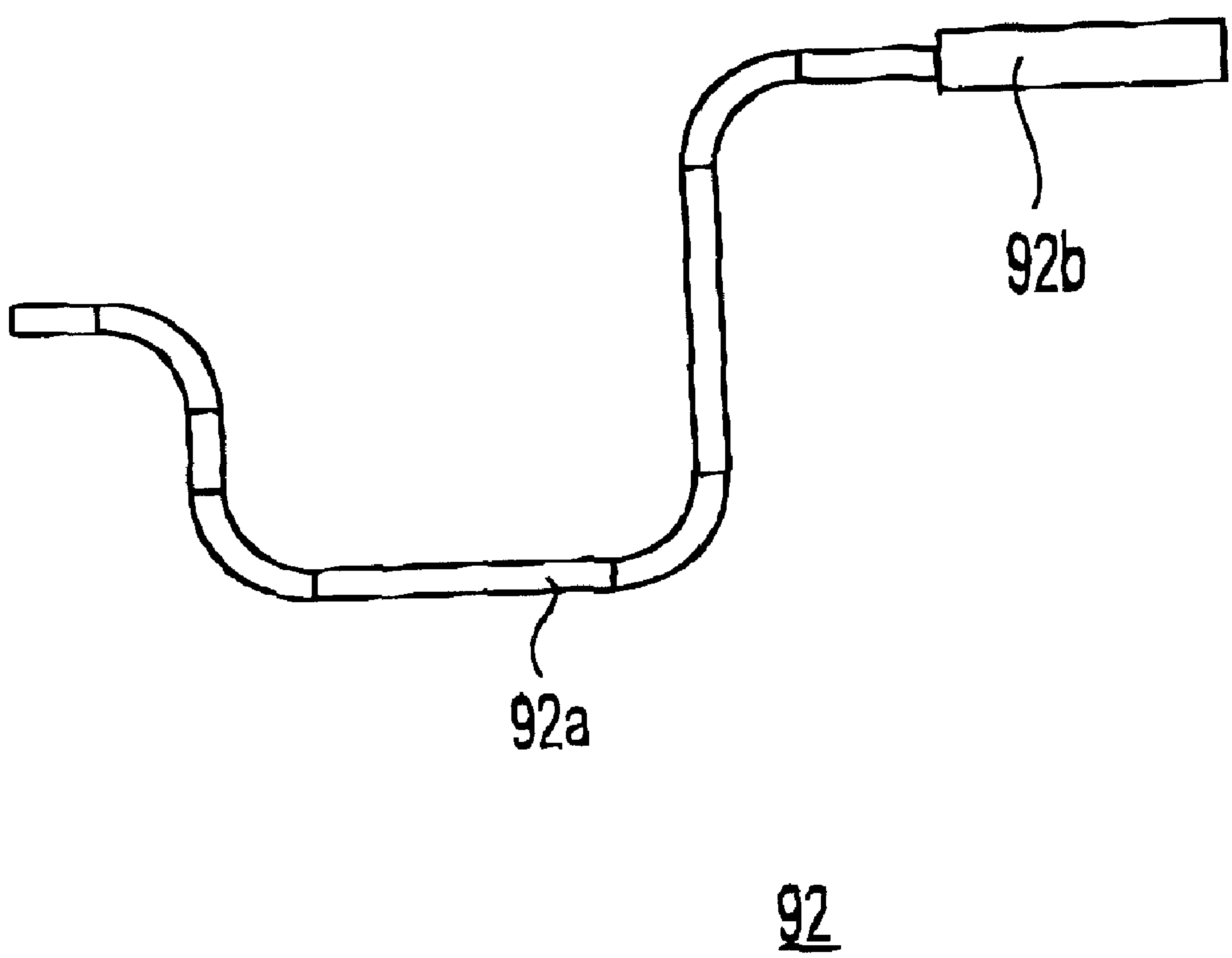

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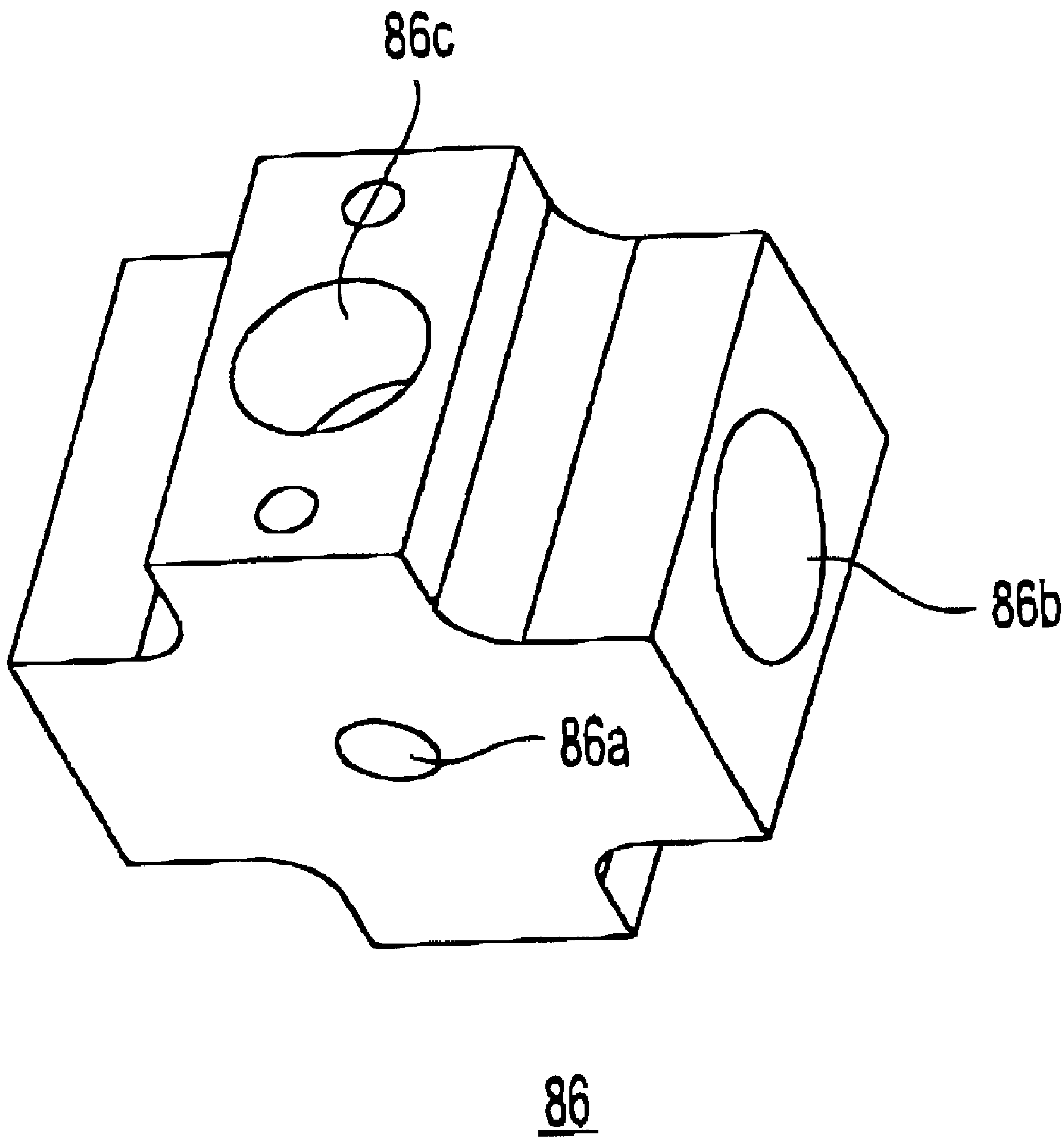

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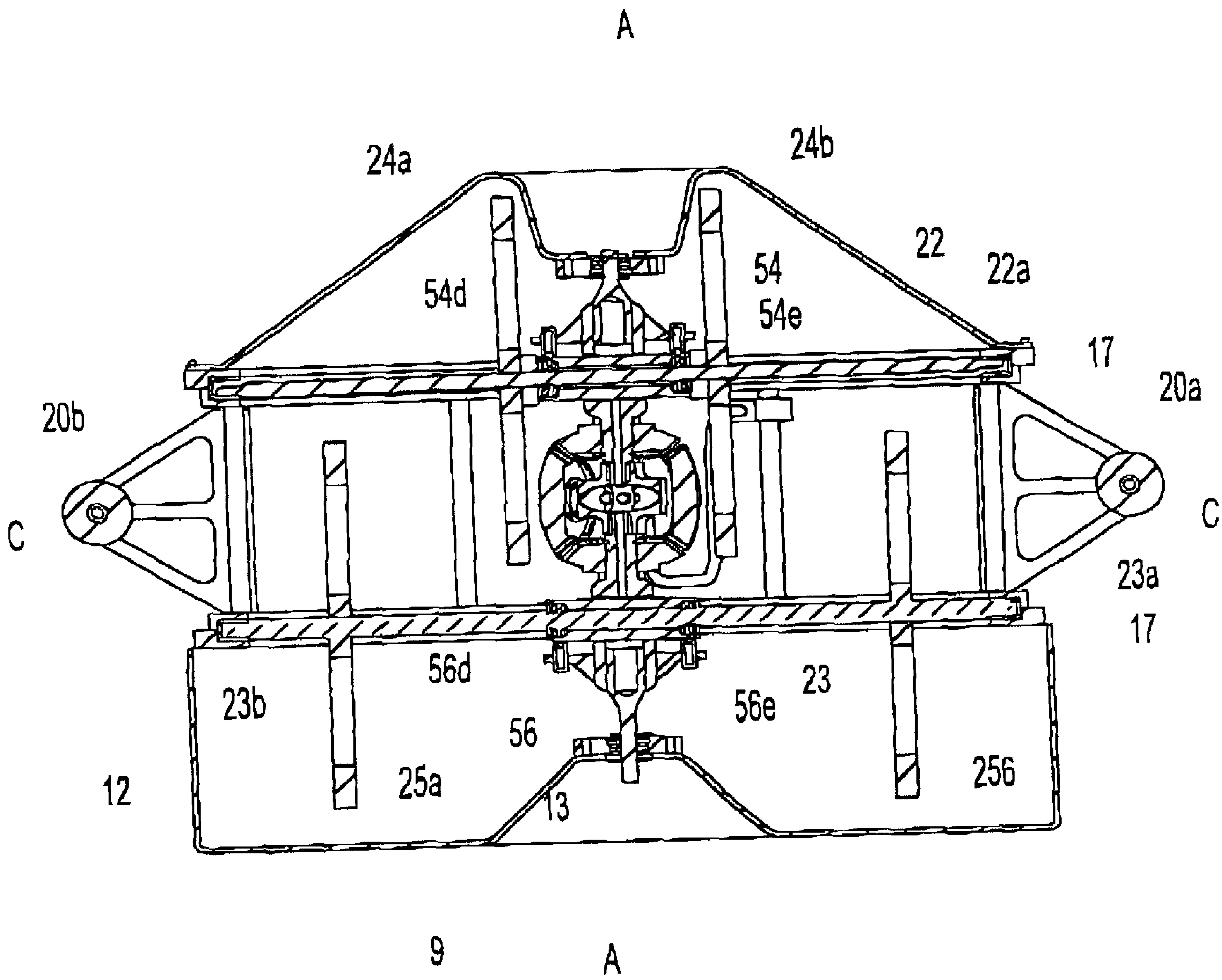
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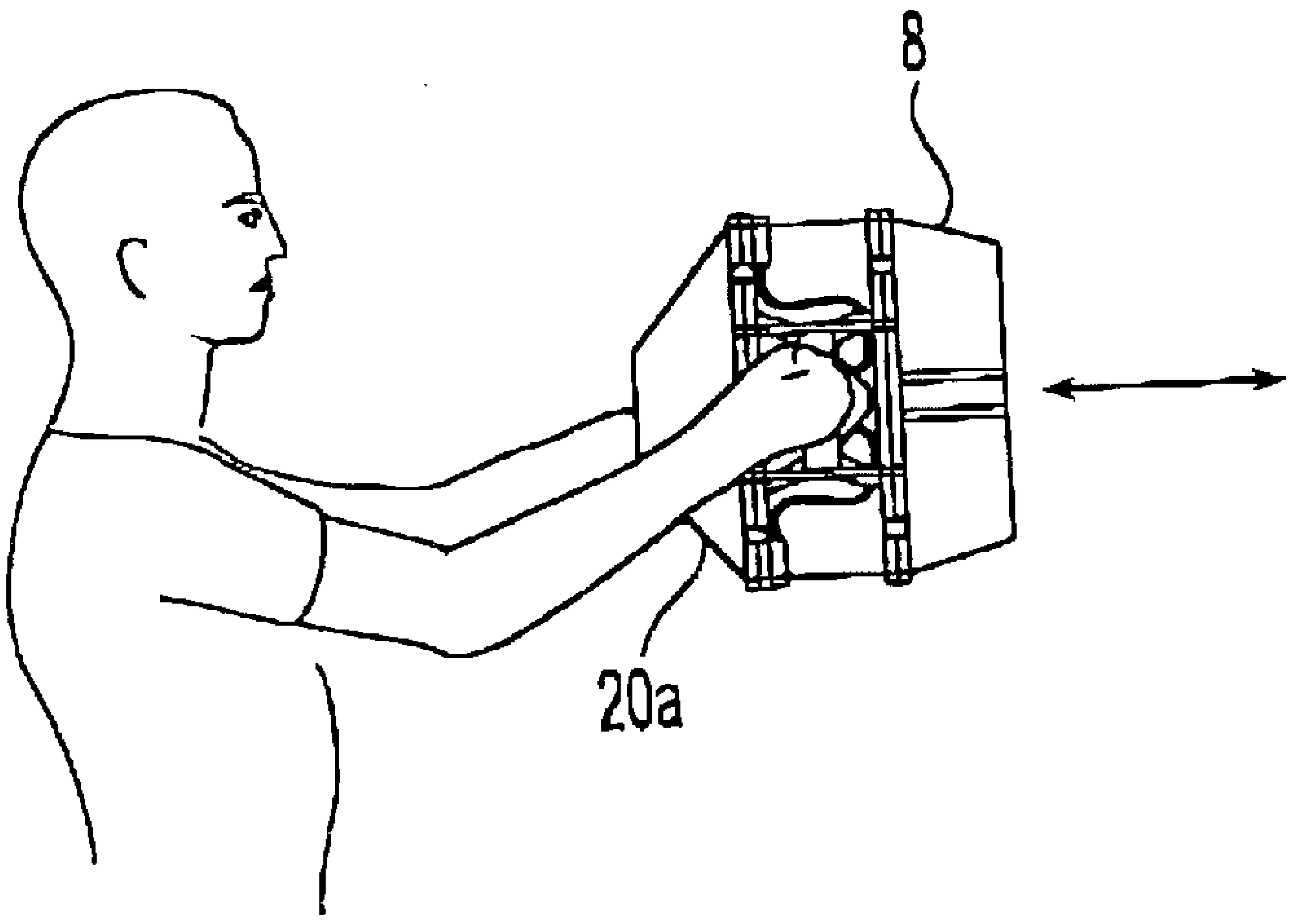
Fig. 16



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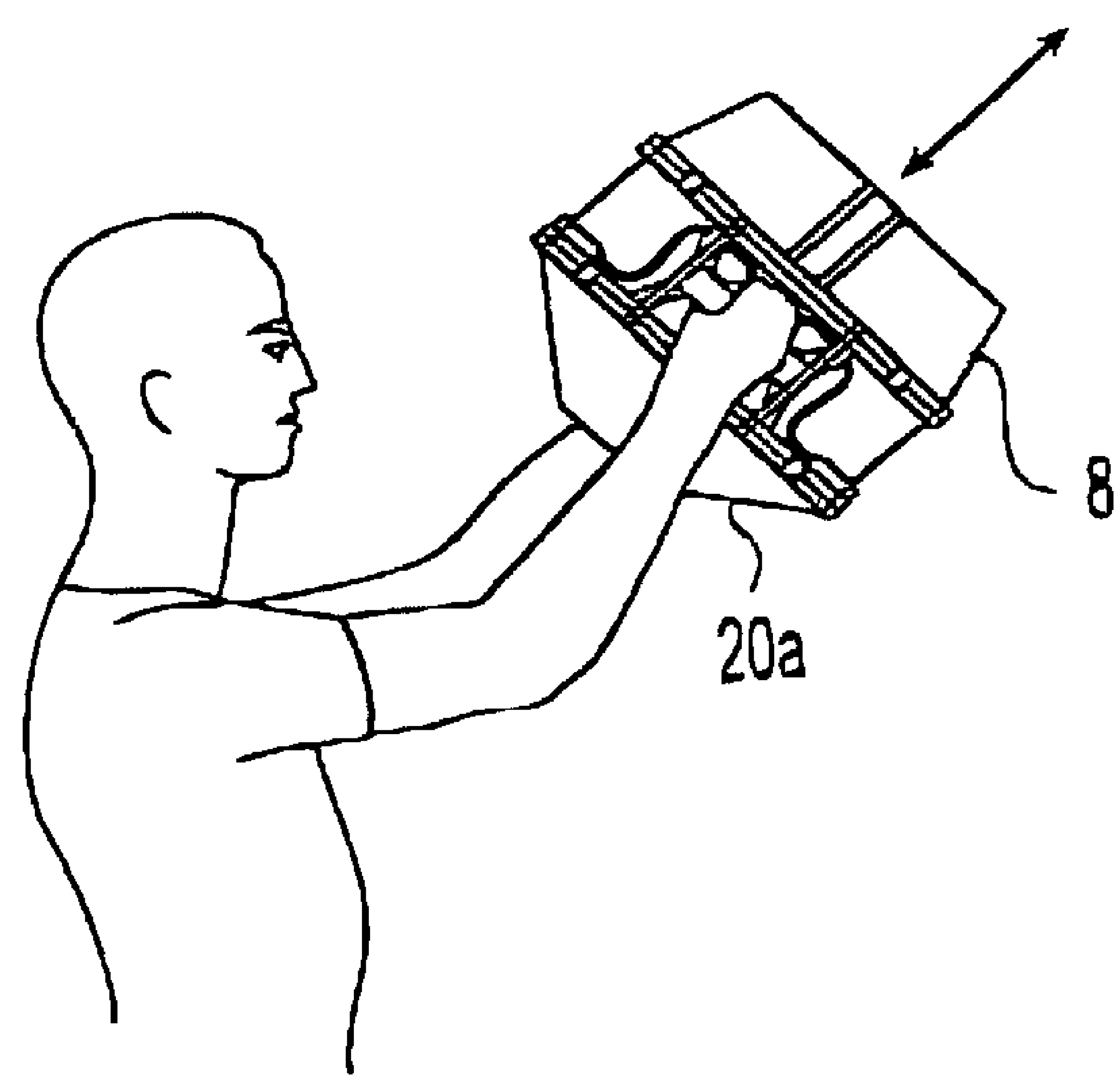

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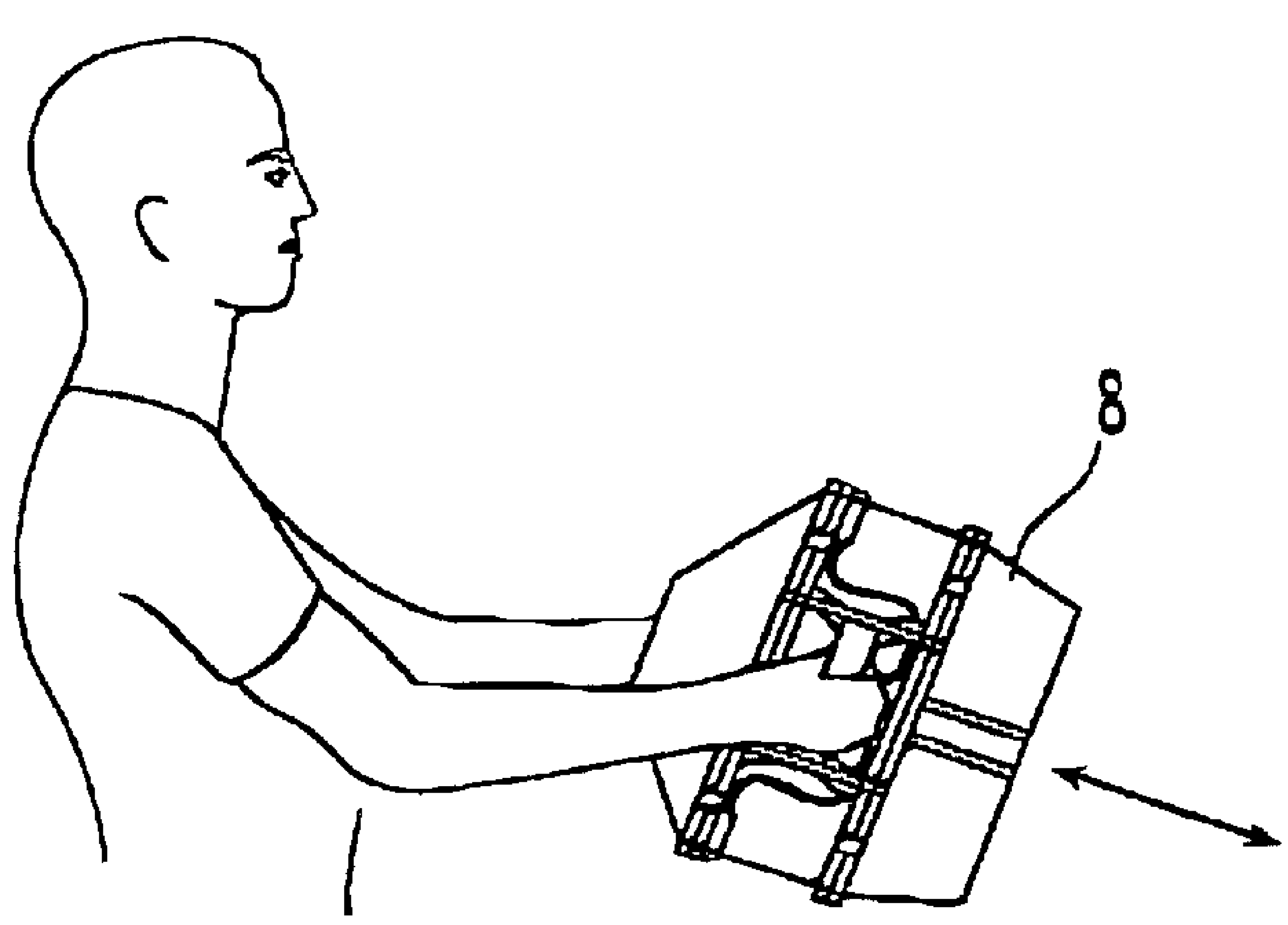

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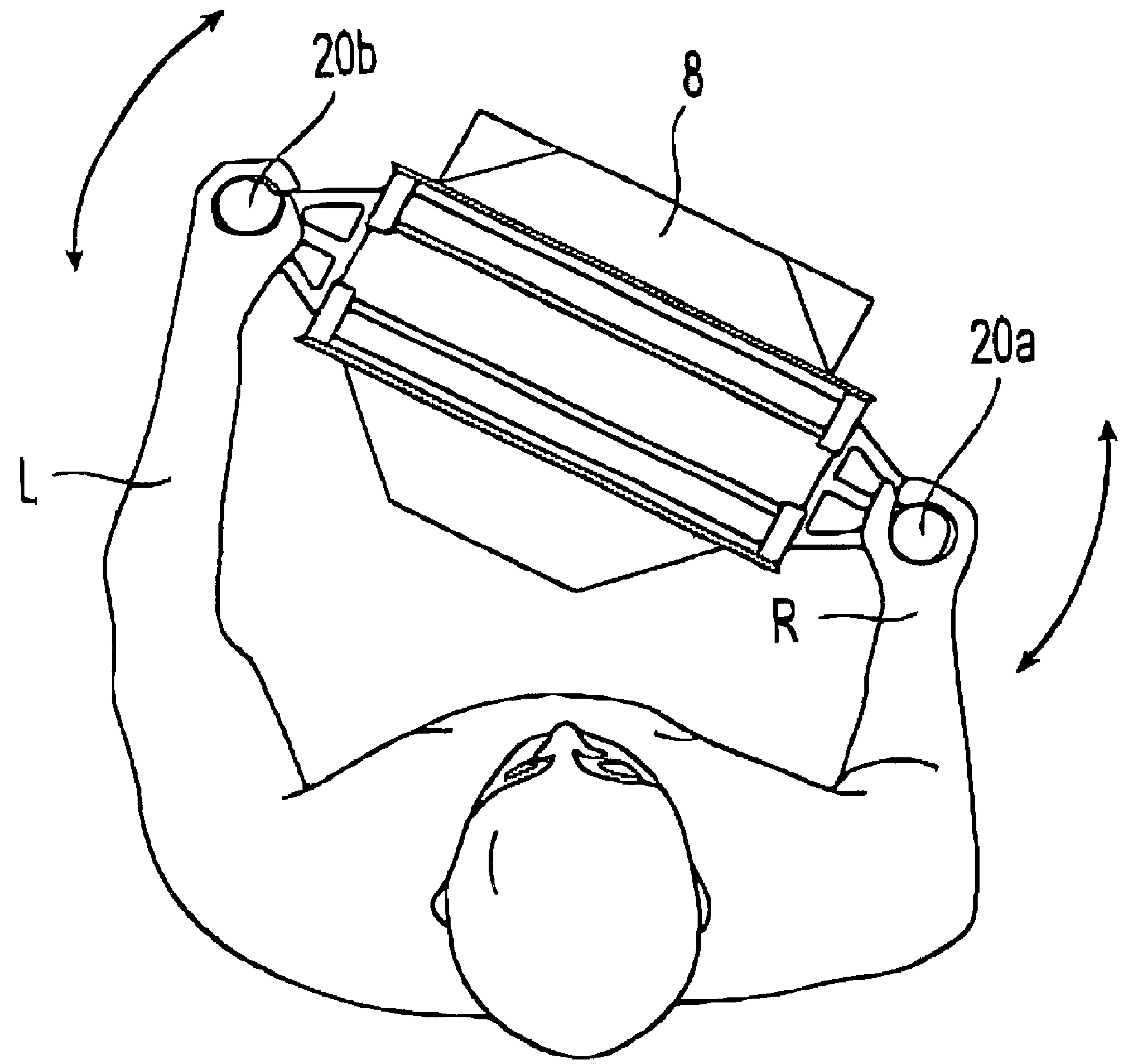

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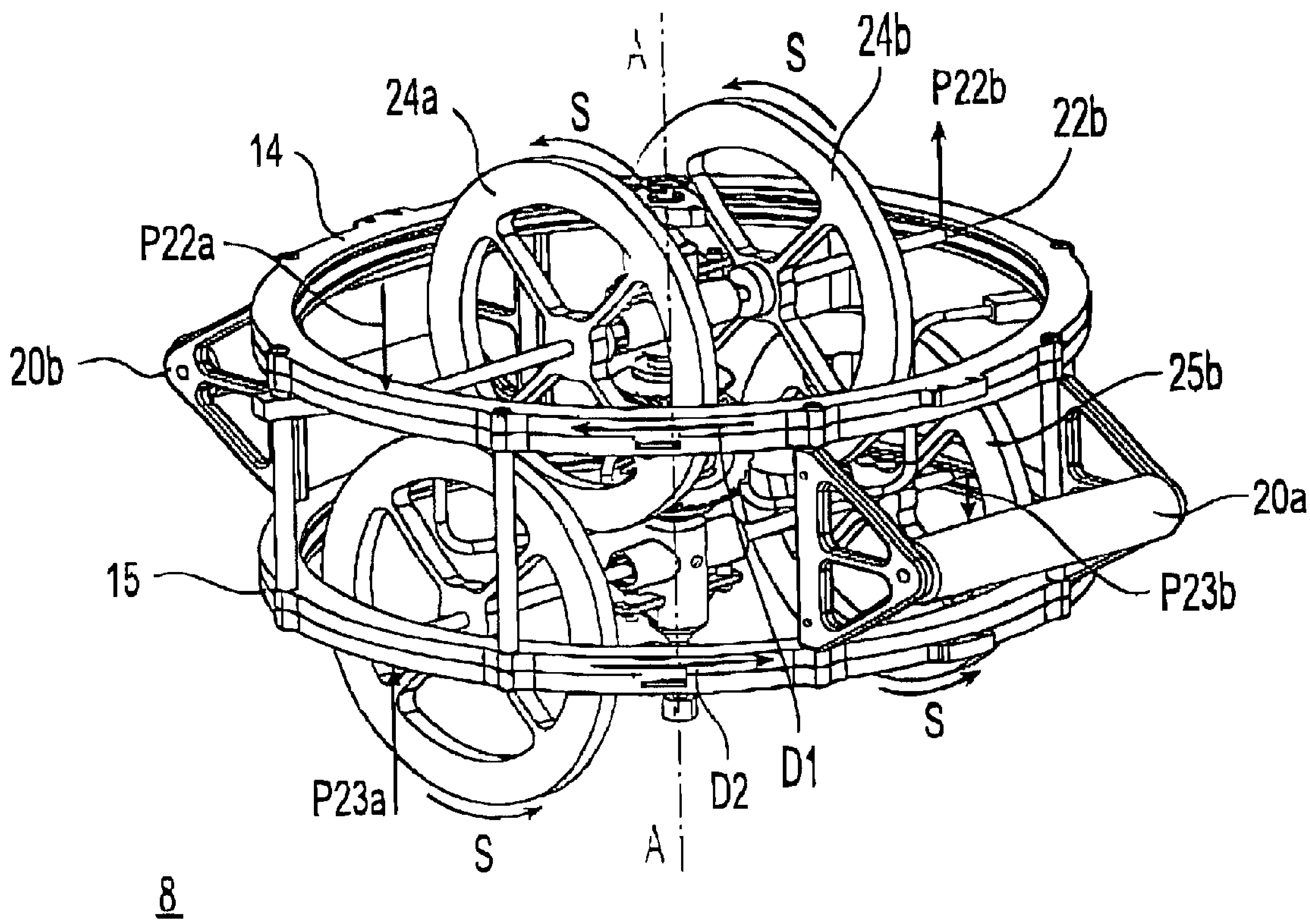

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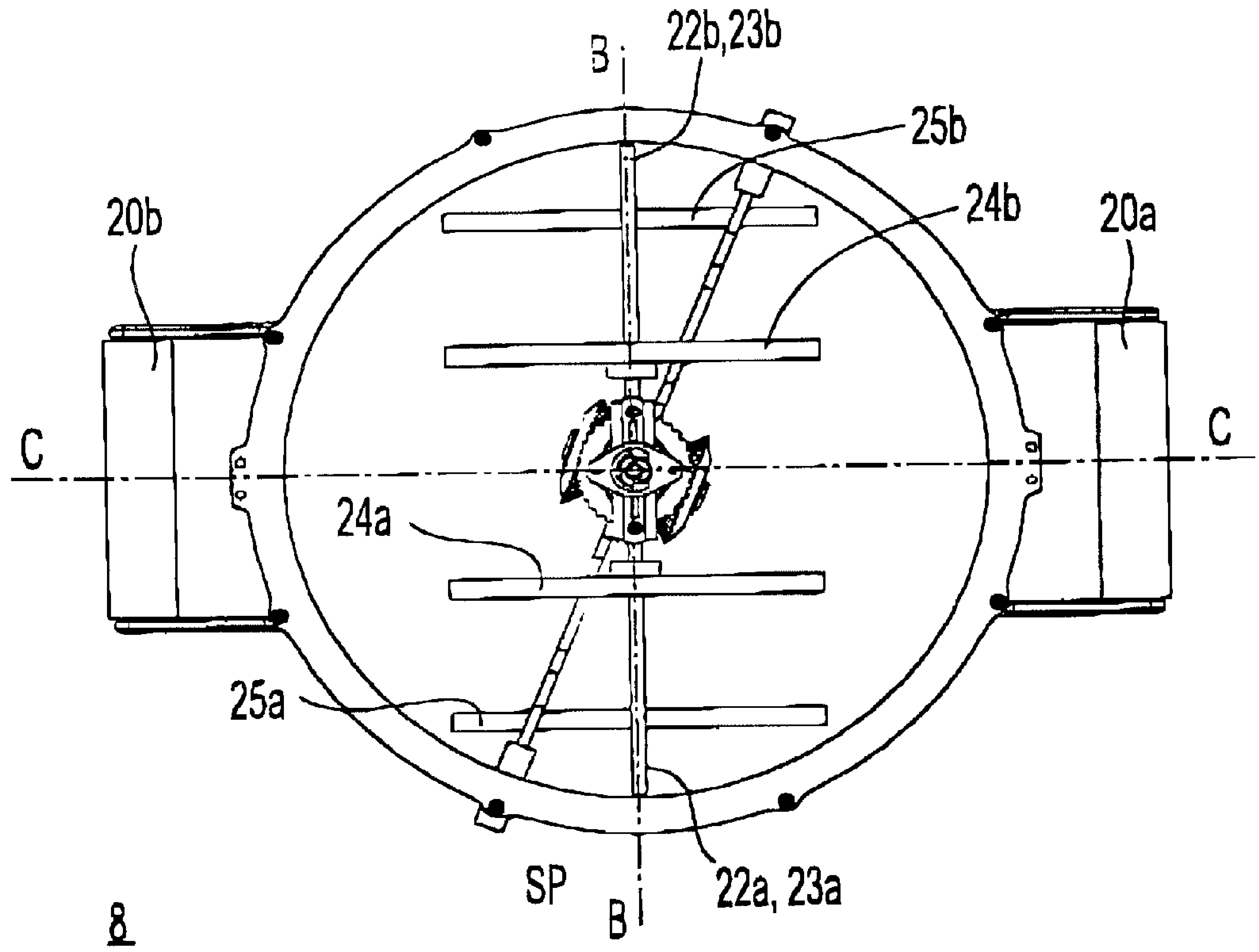

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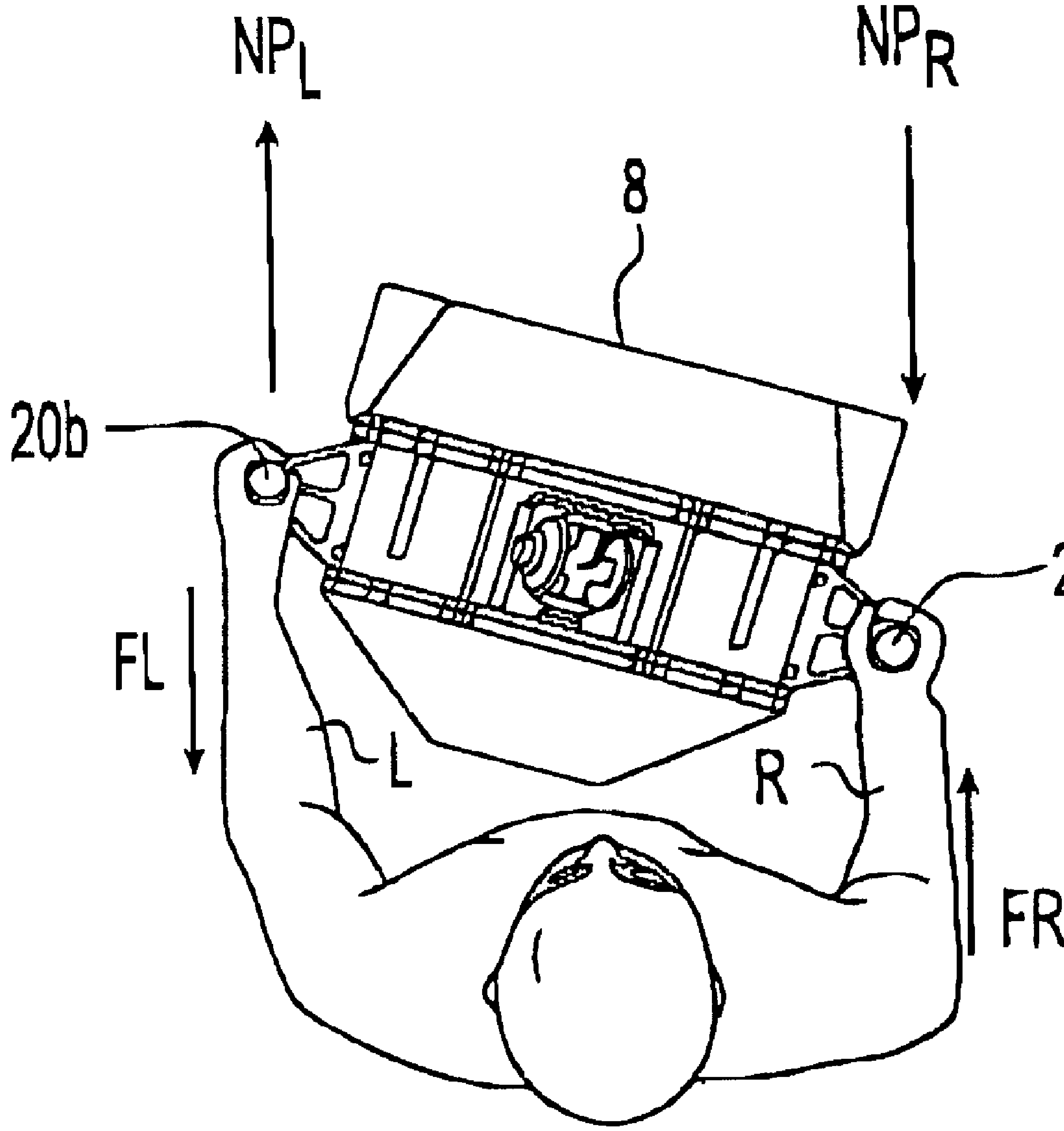

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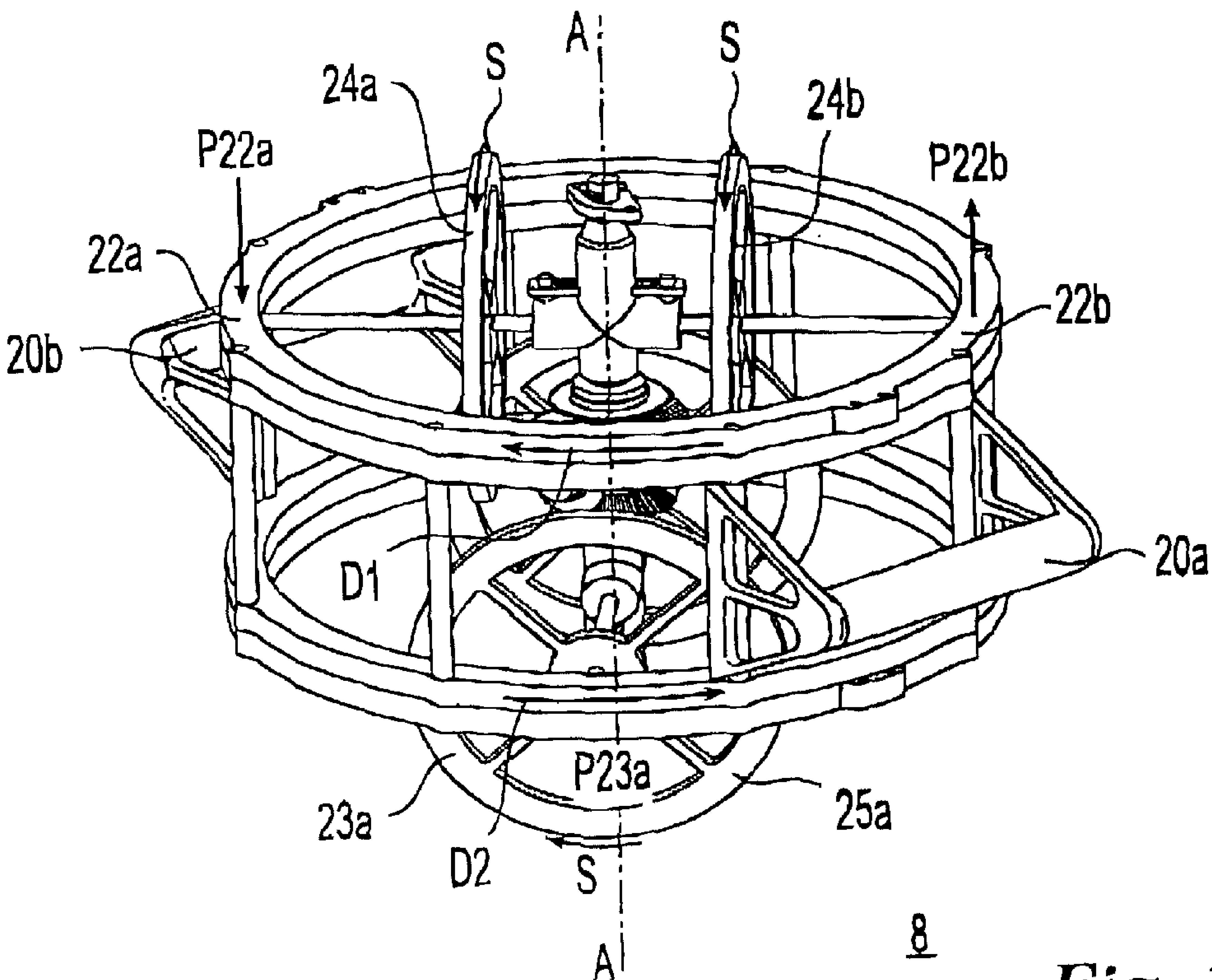

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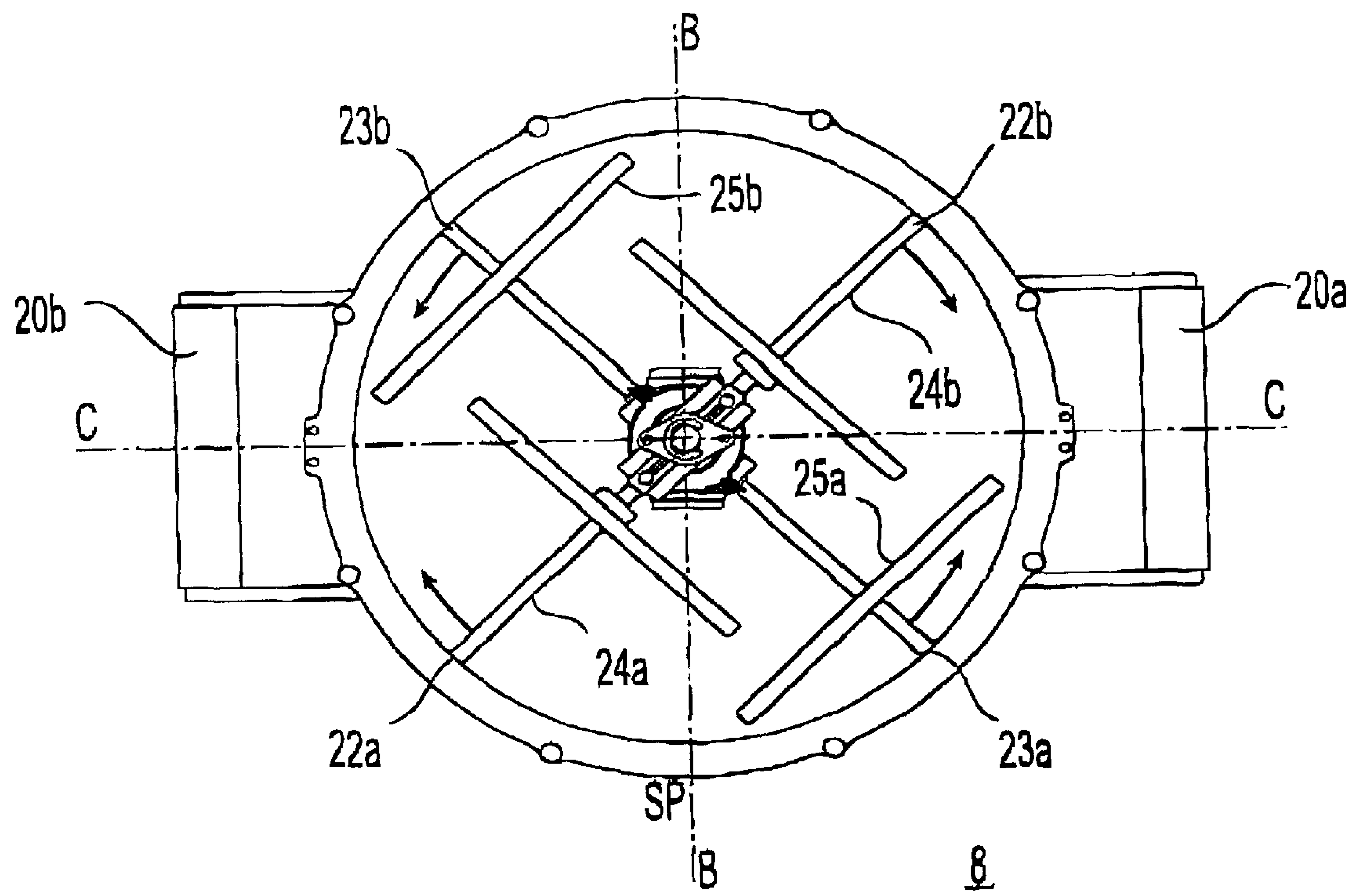

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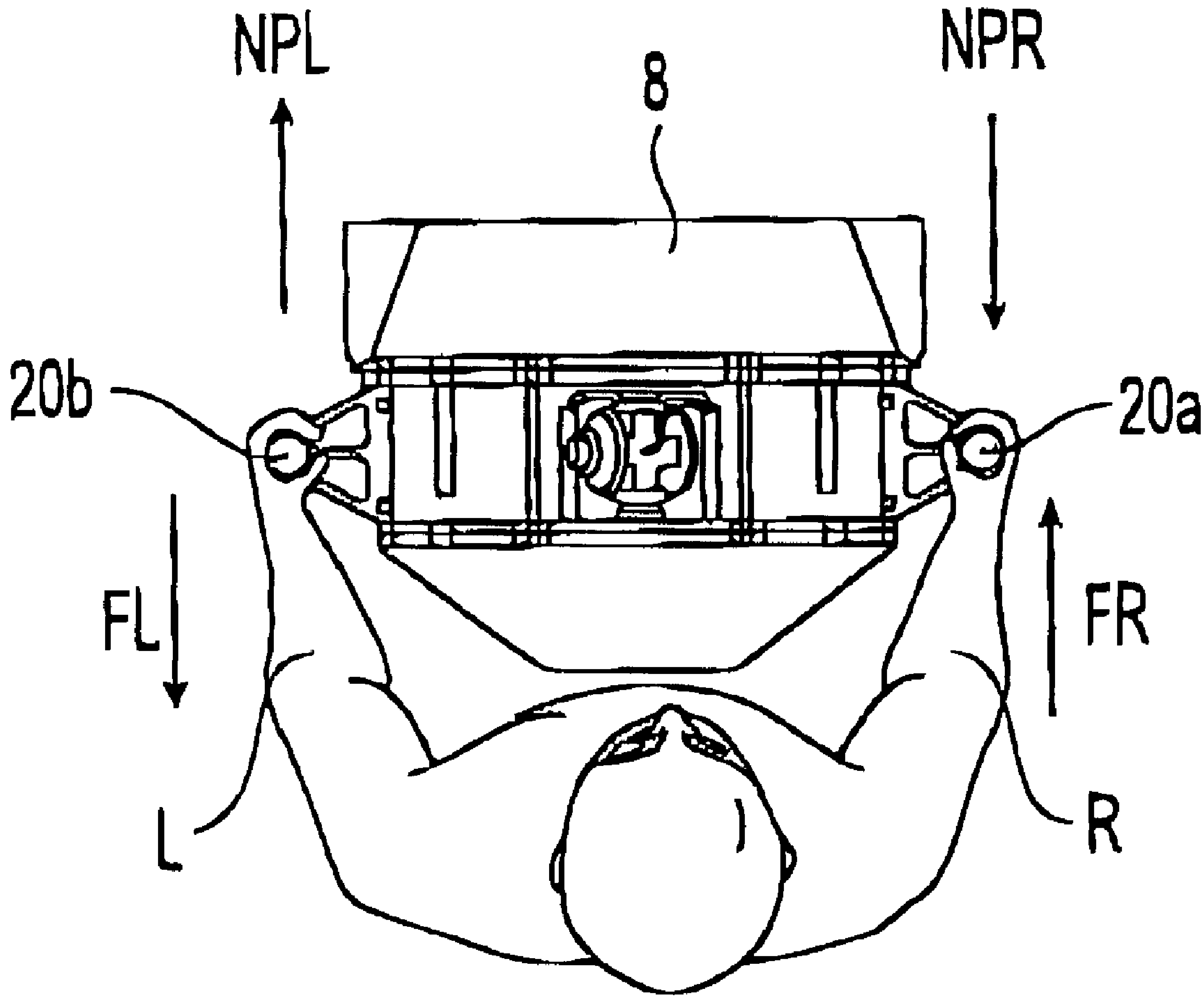

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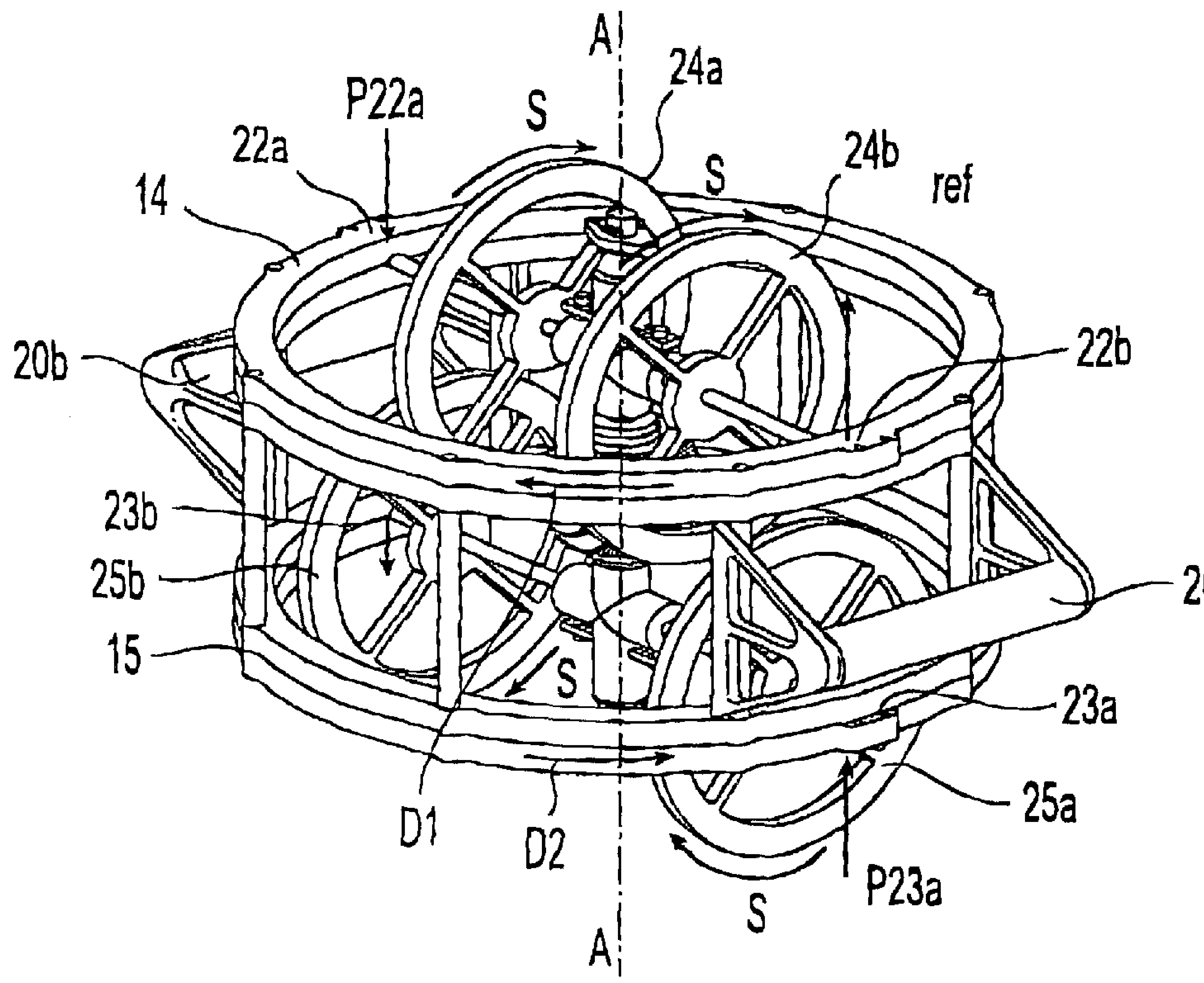

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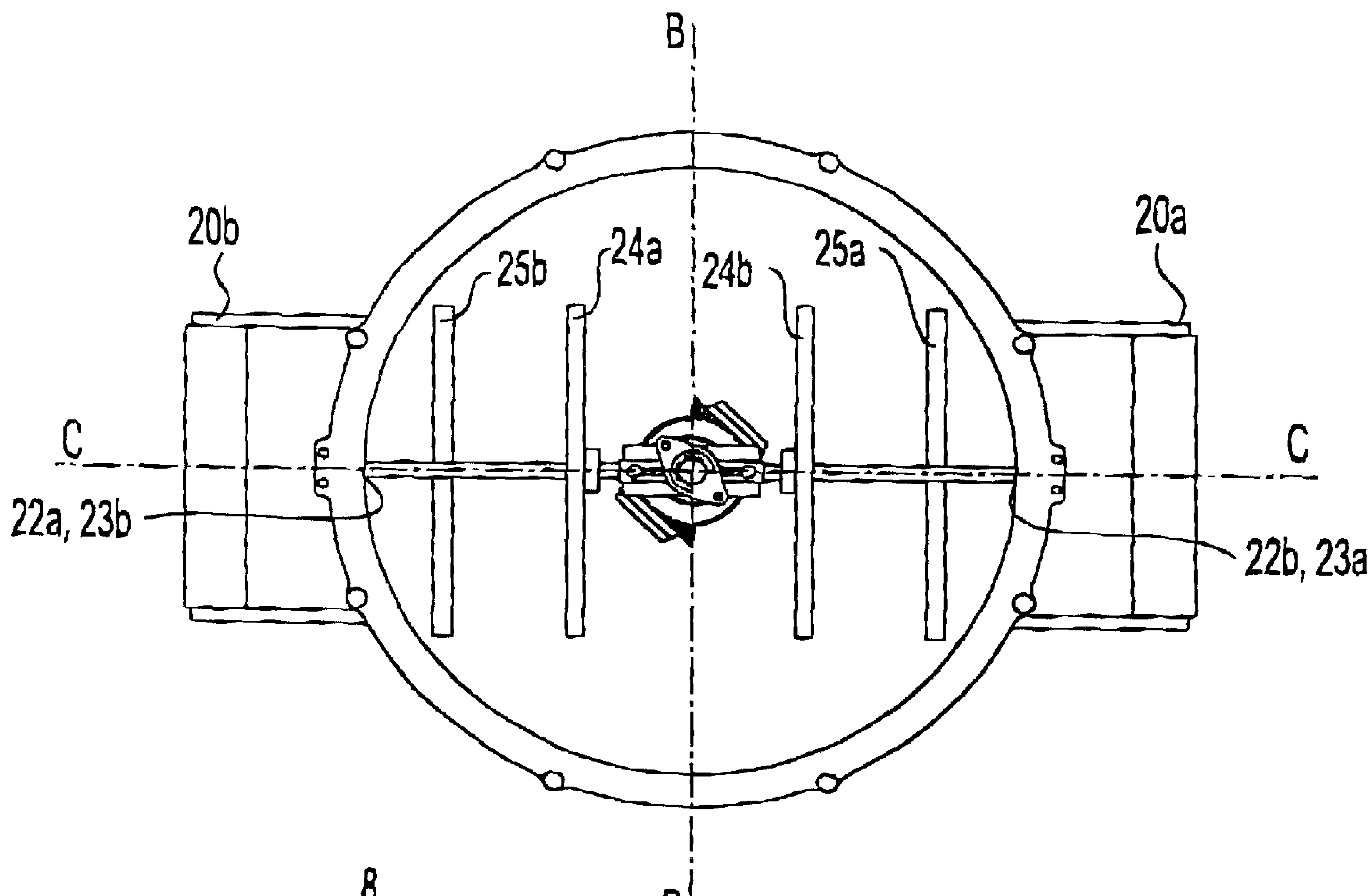

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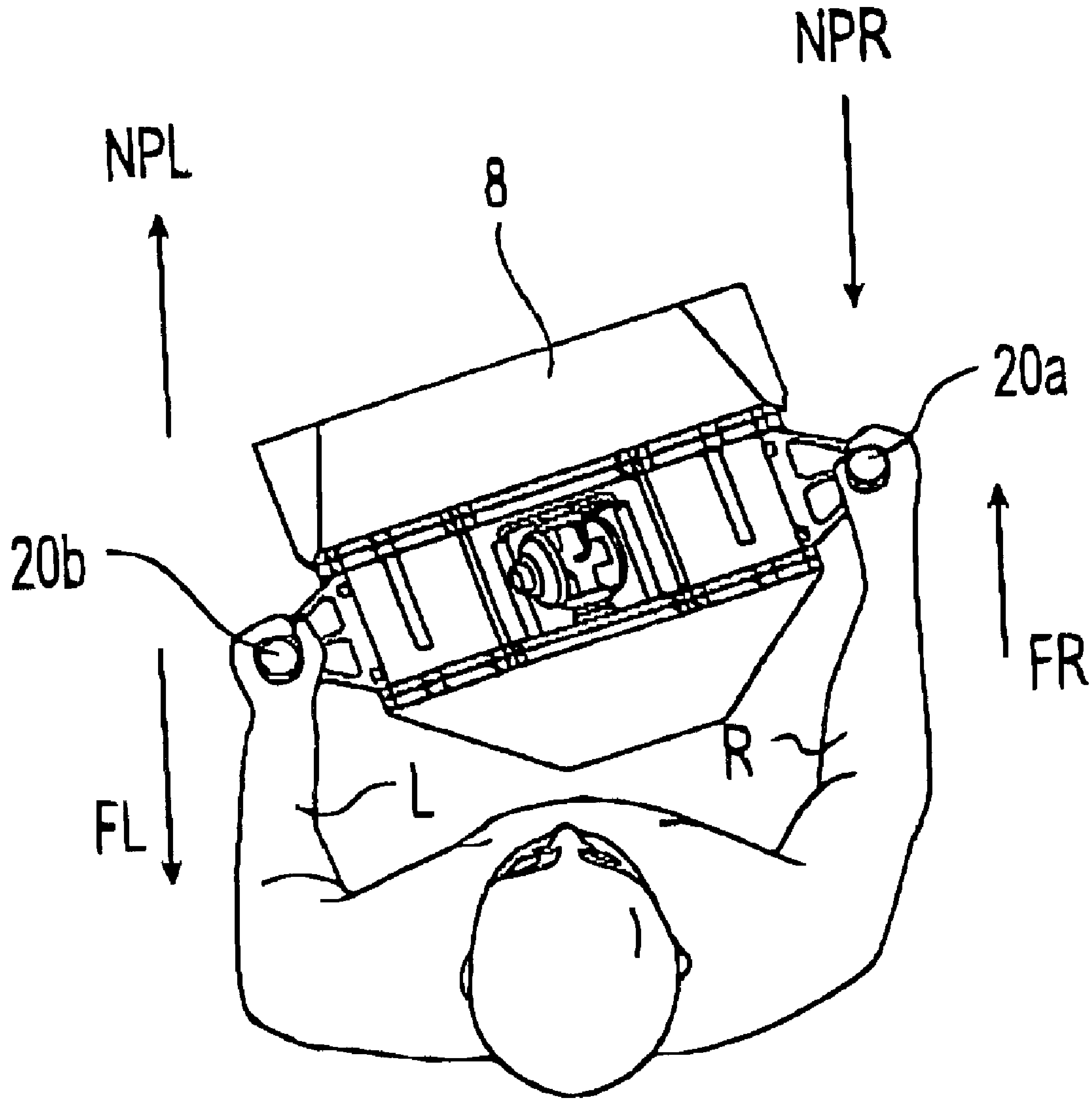

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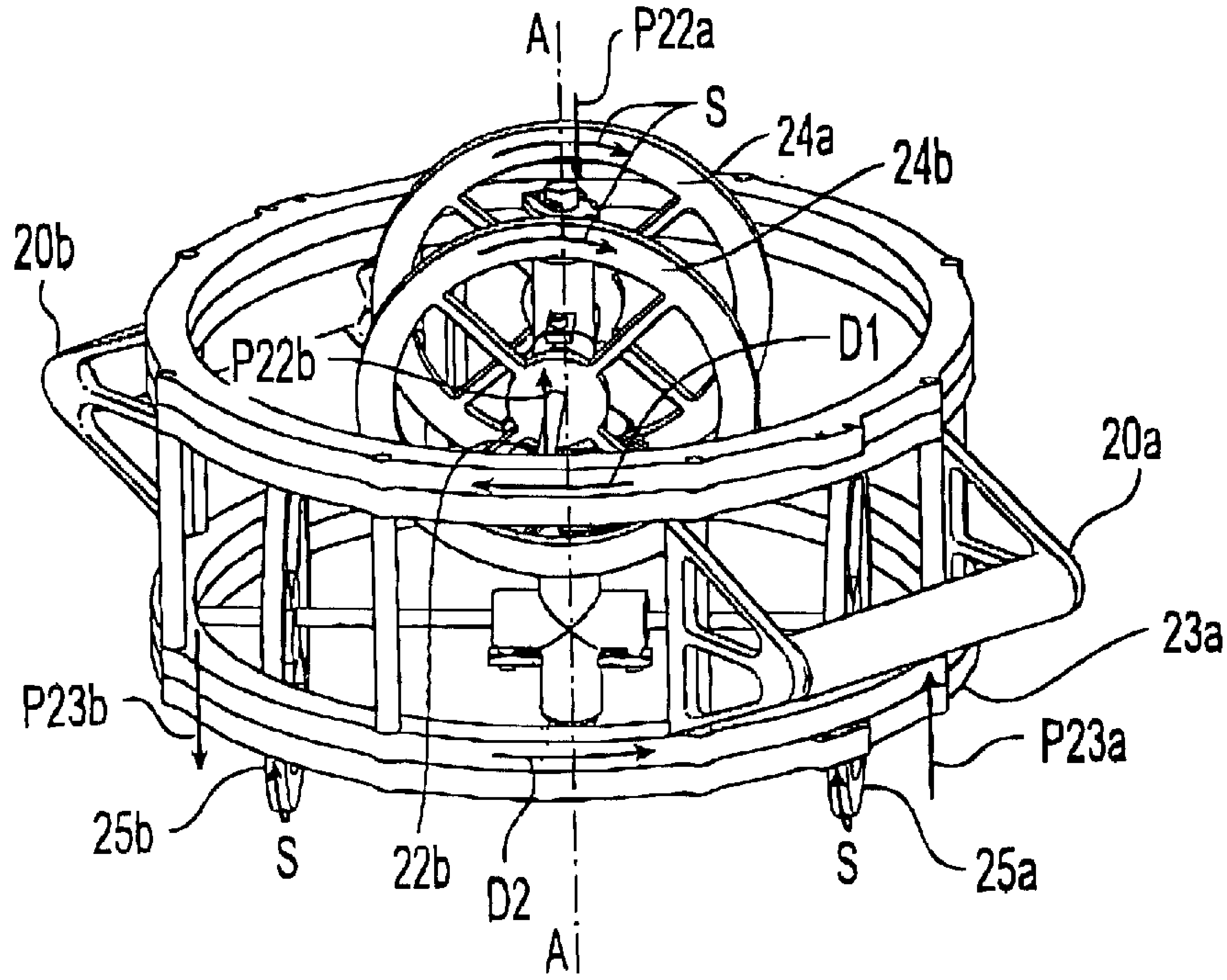

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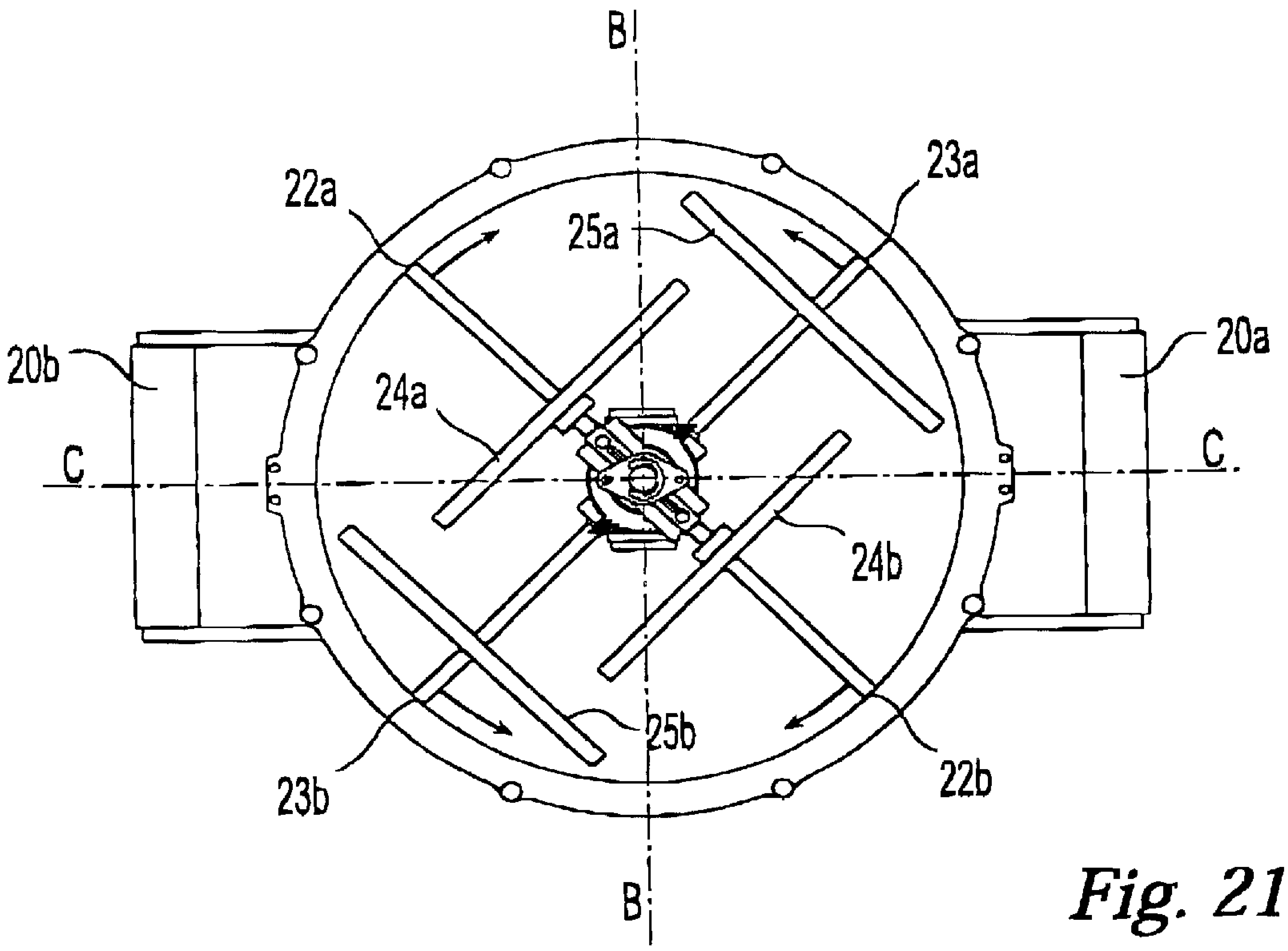

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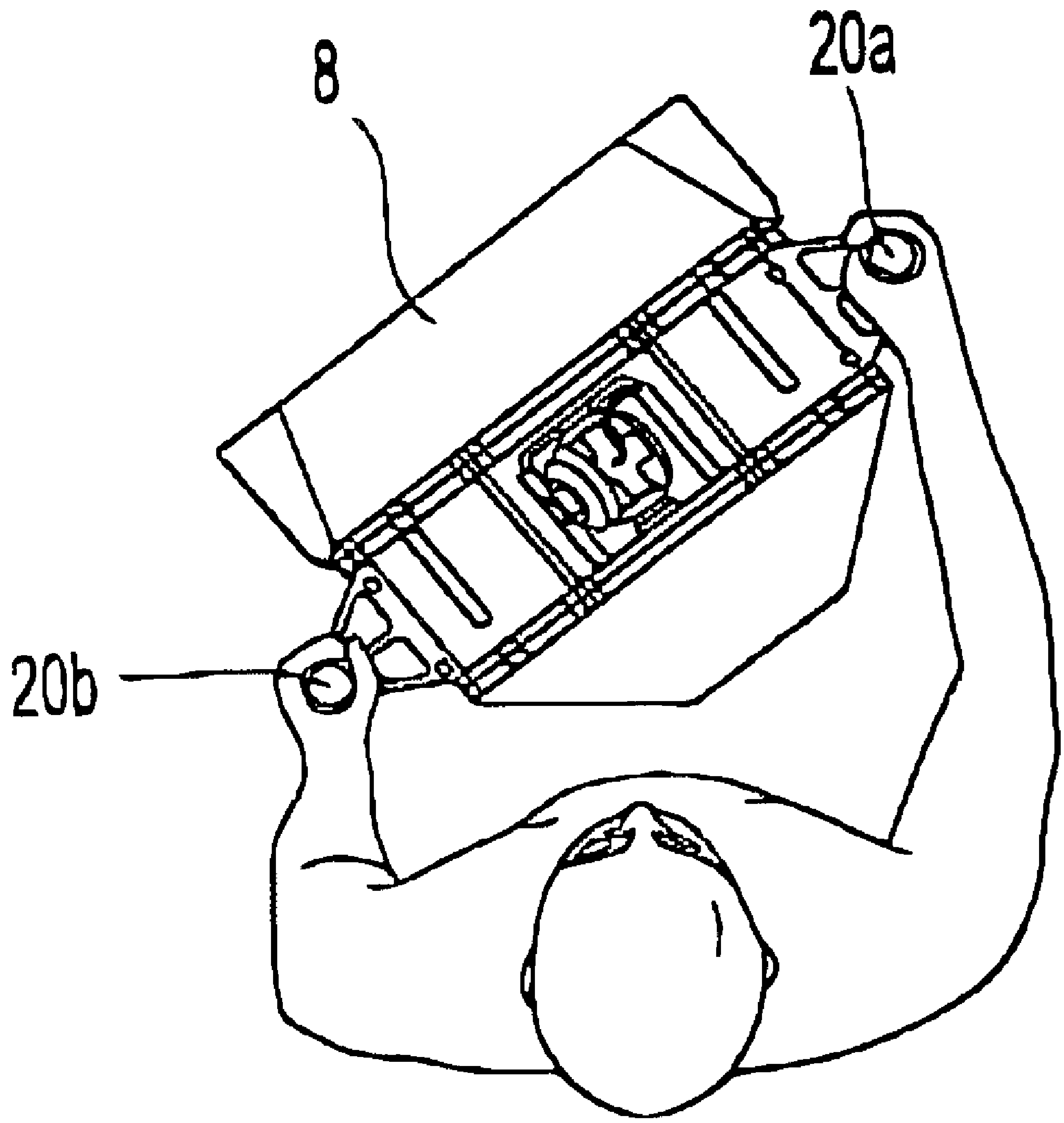

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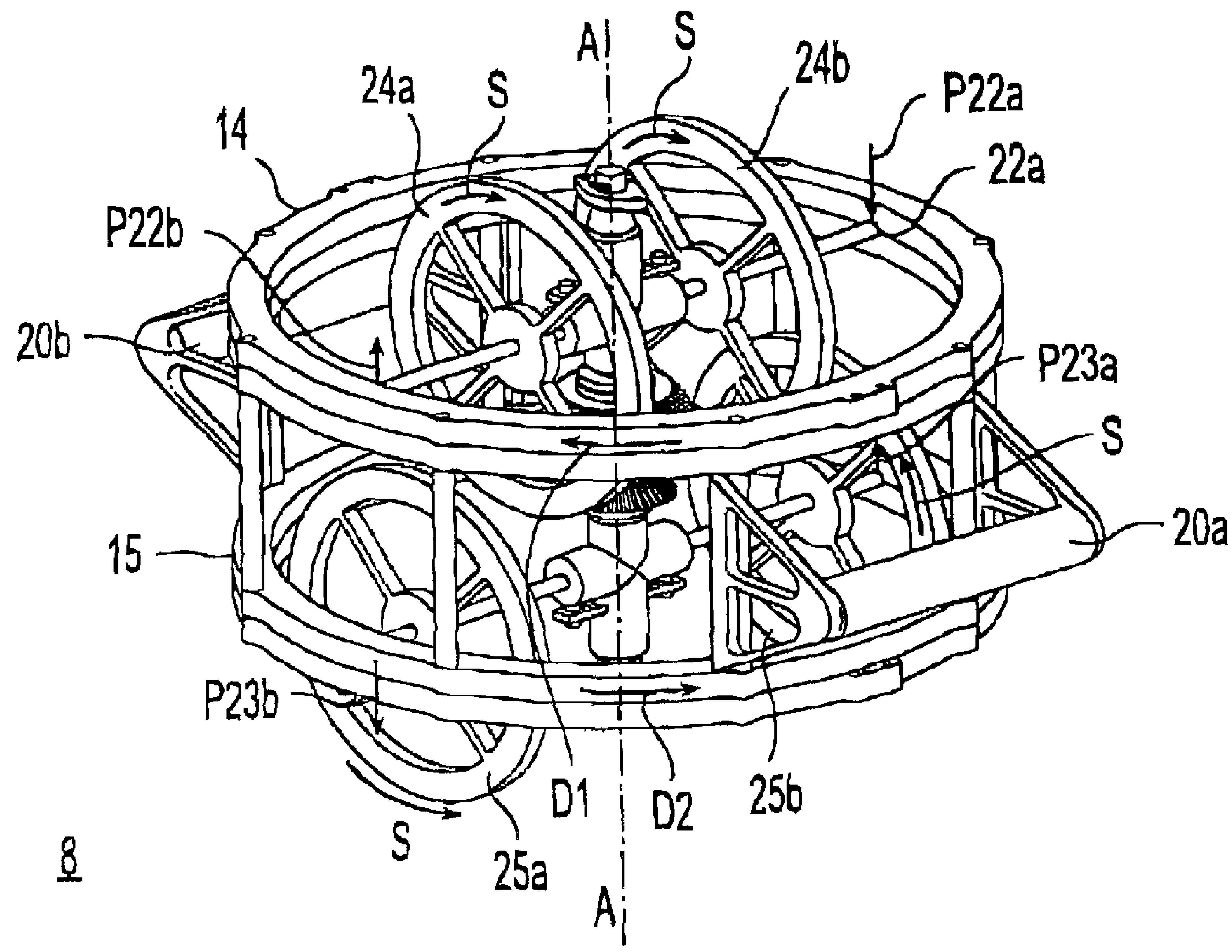

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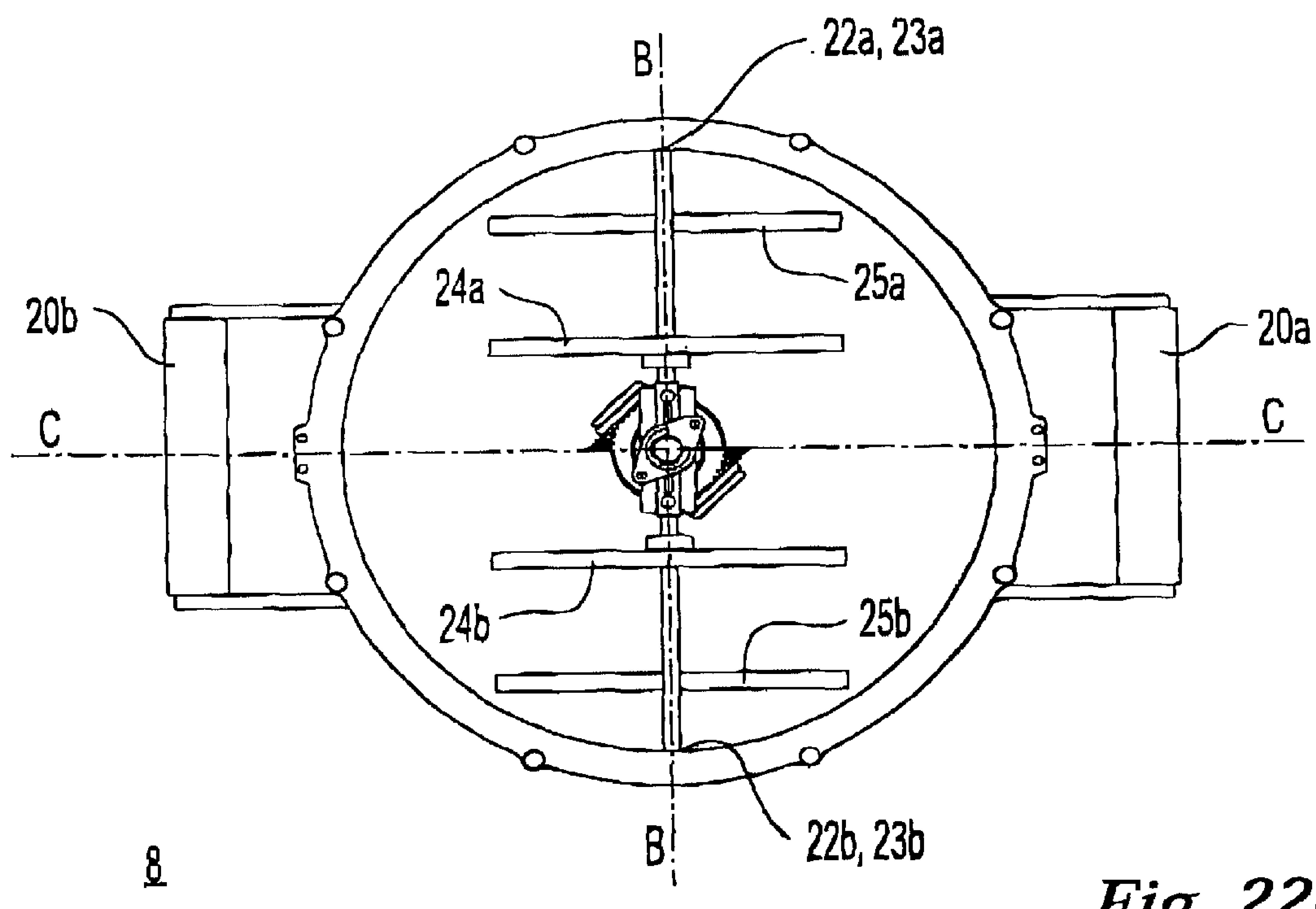

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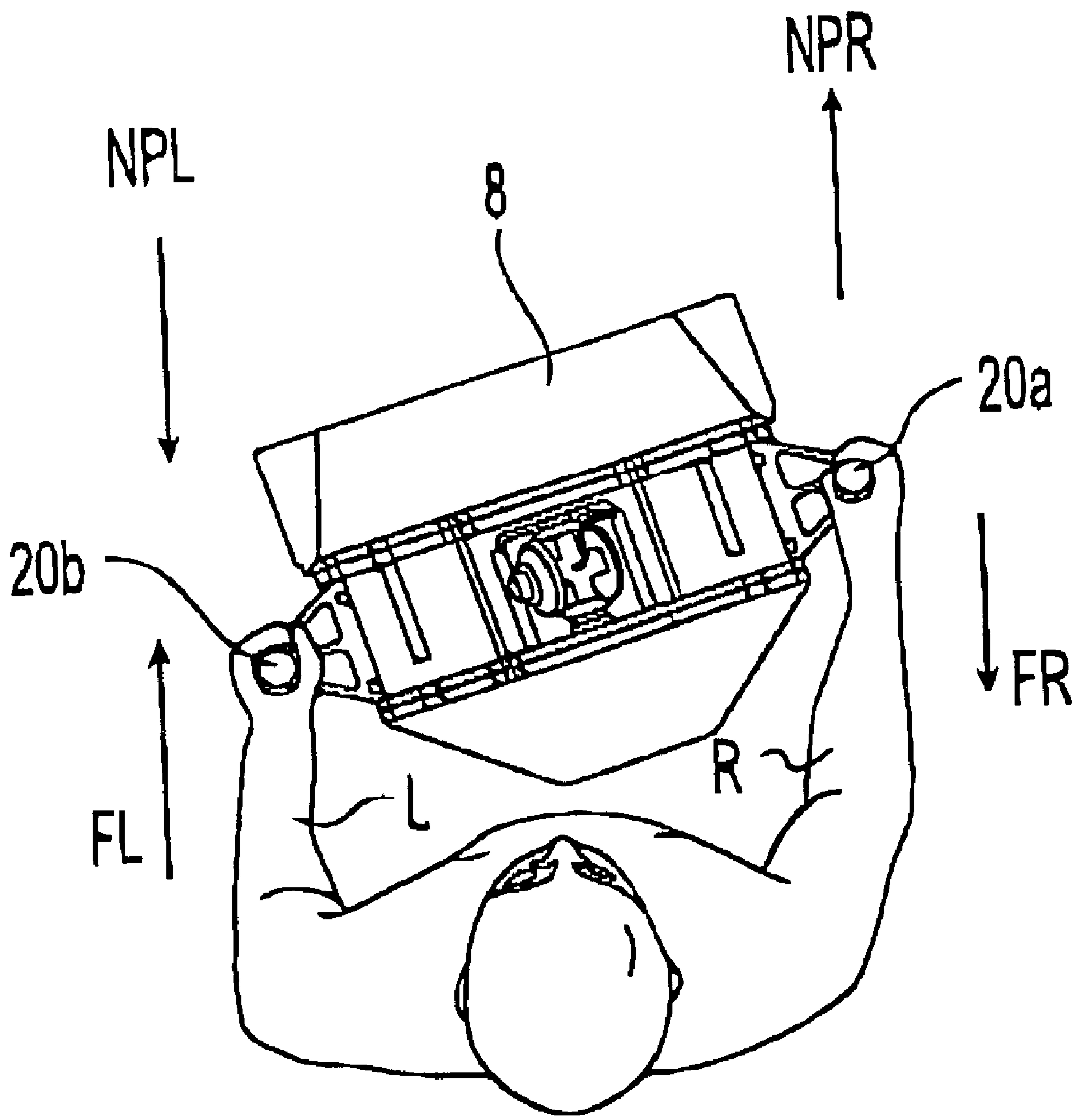

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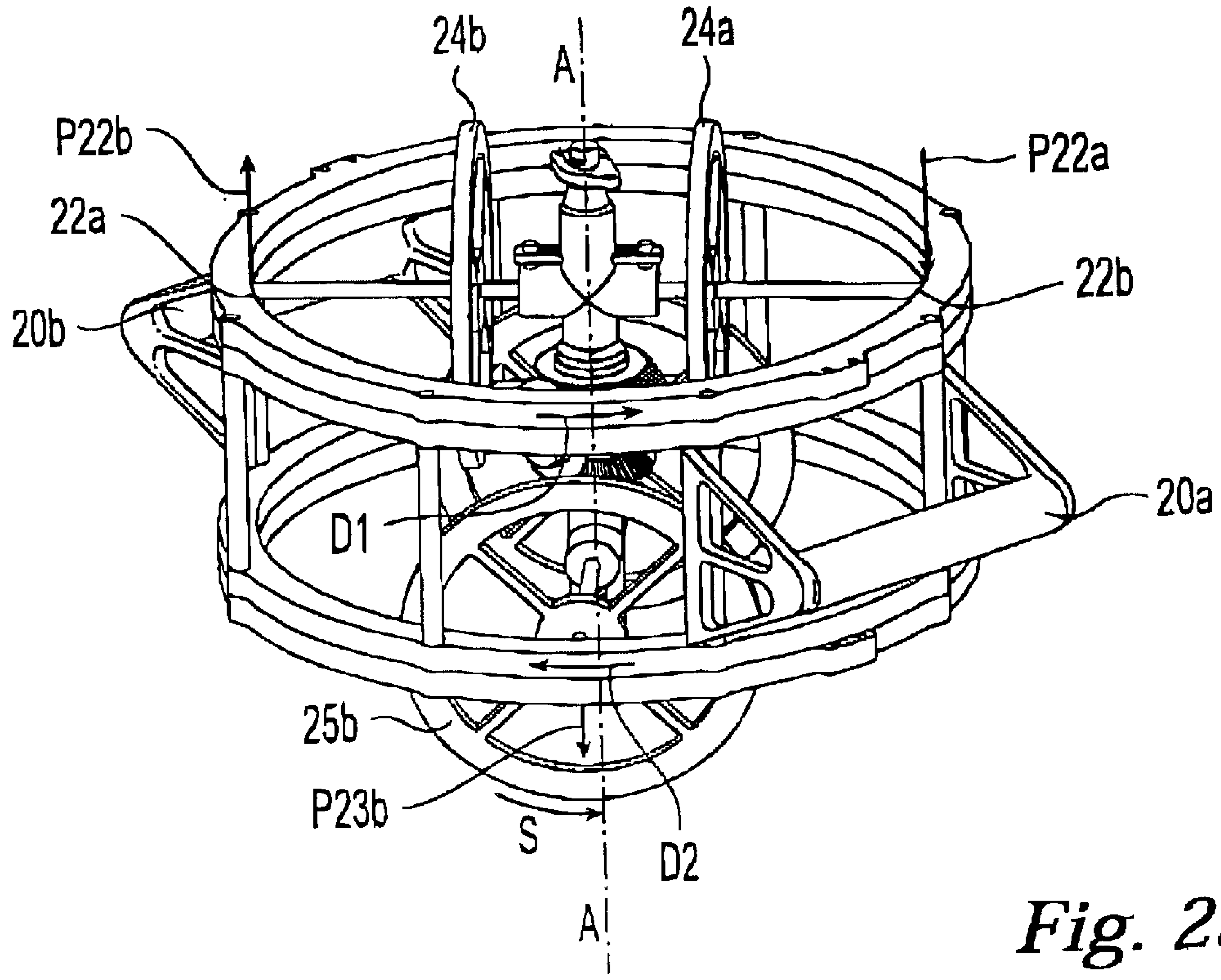

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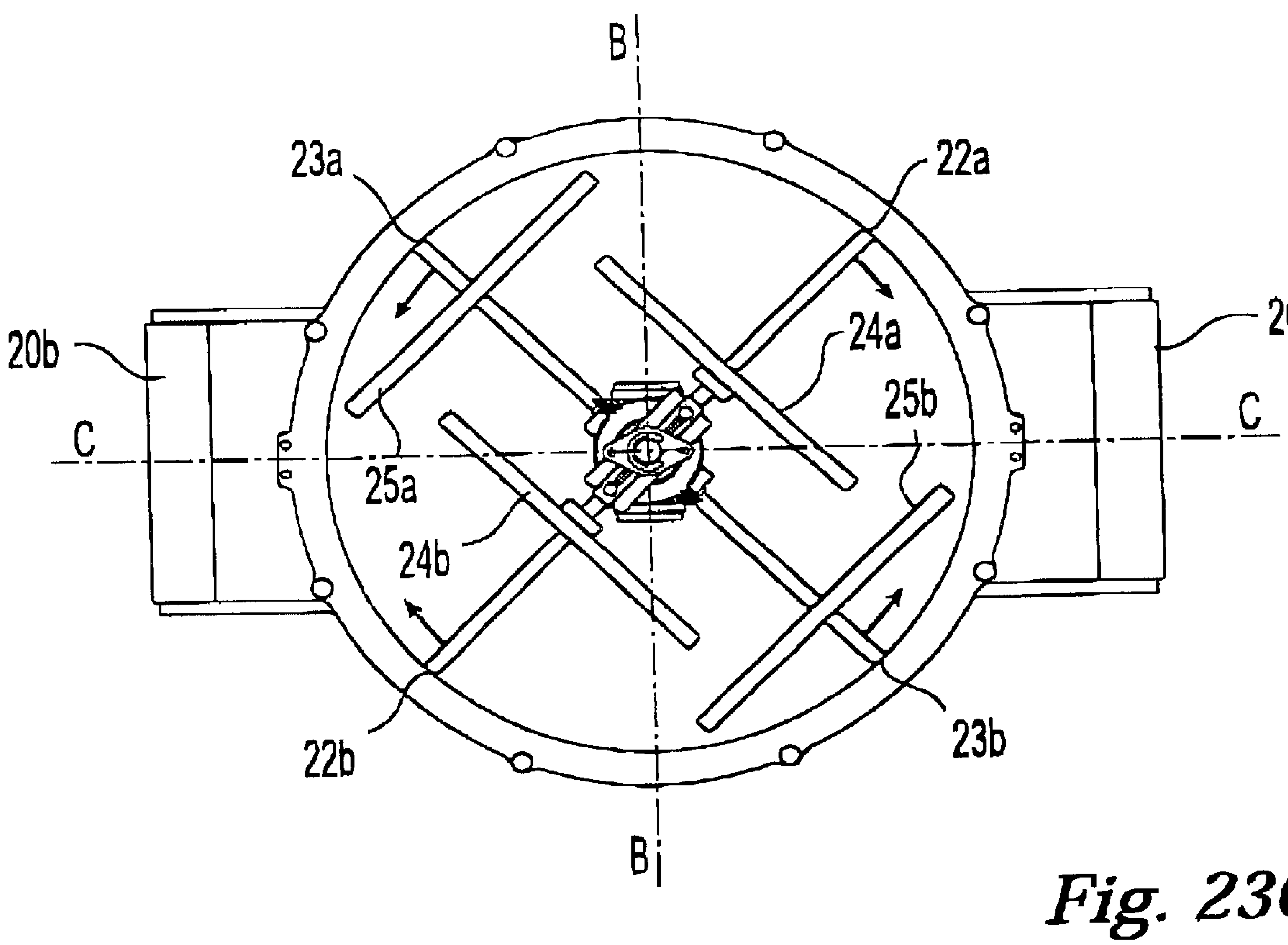

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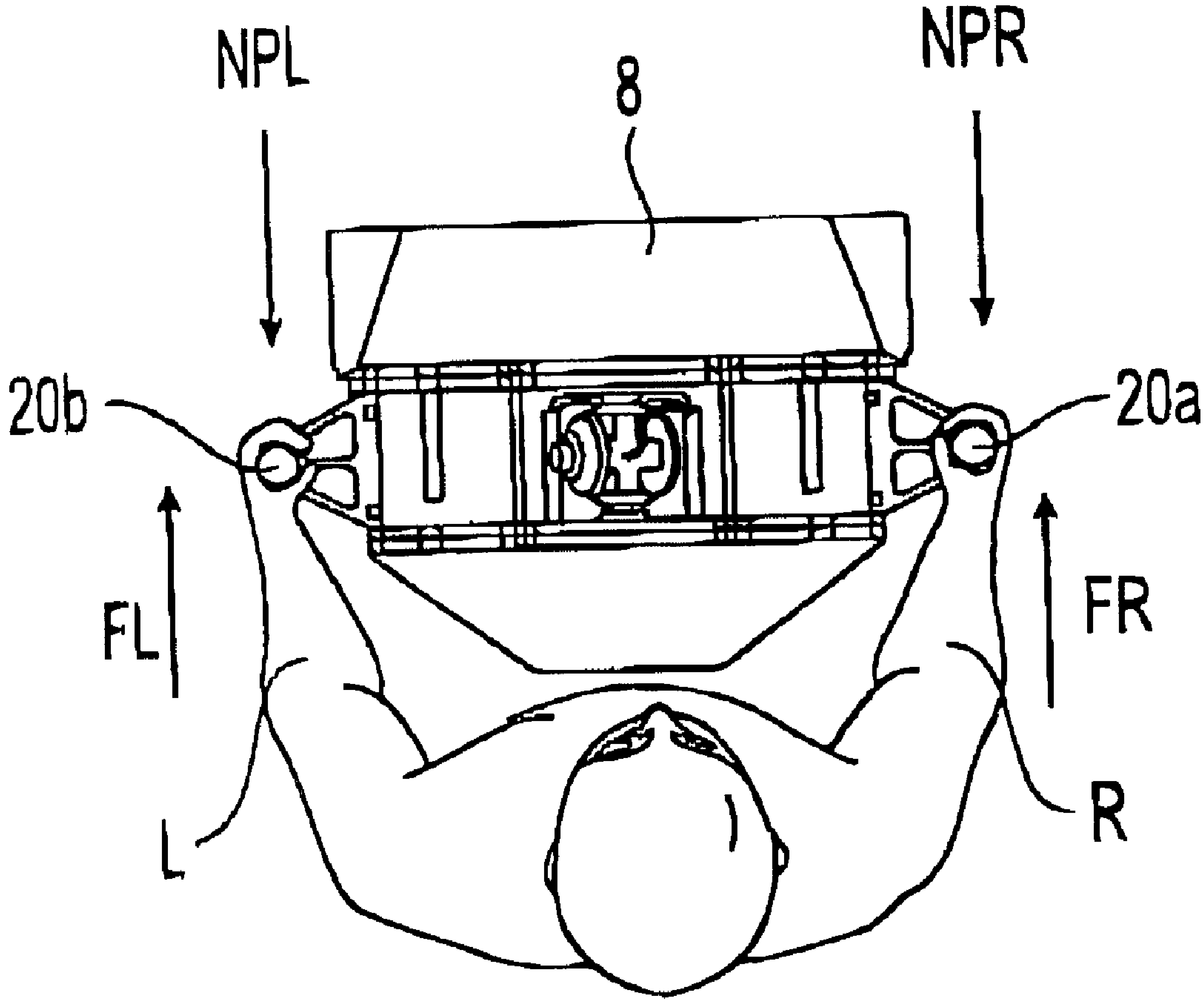

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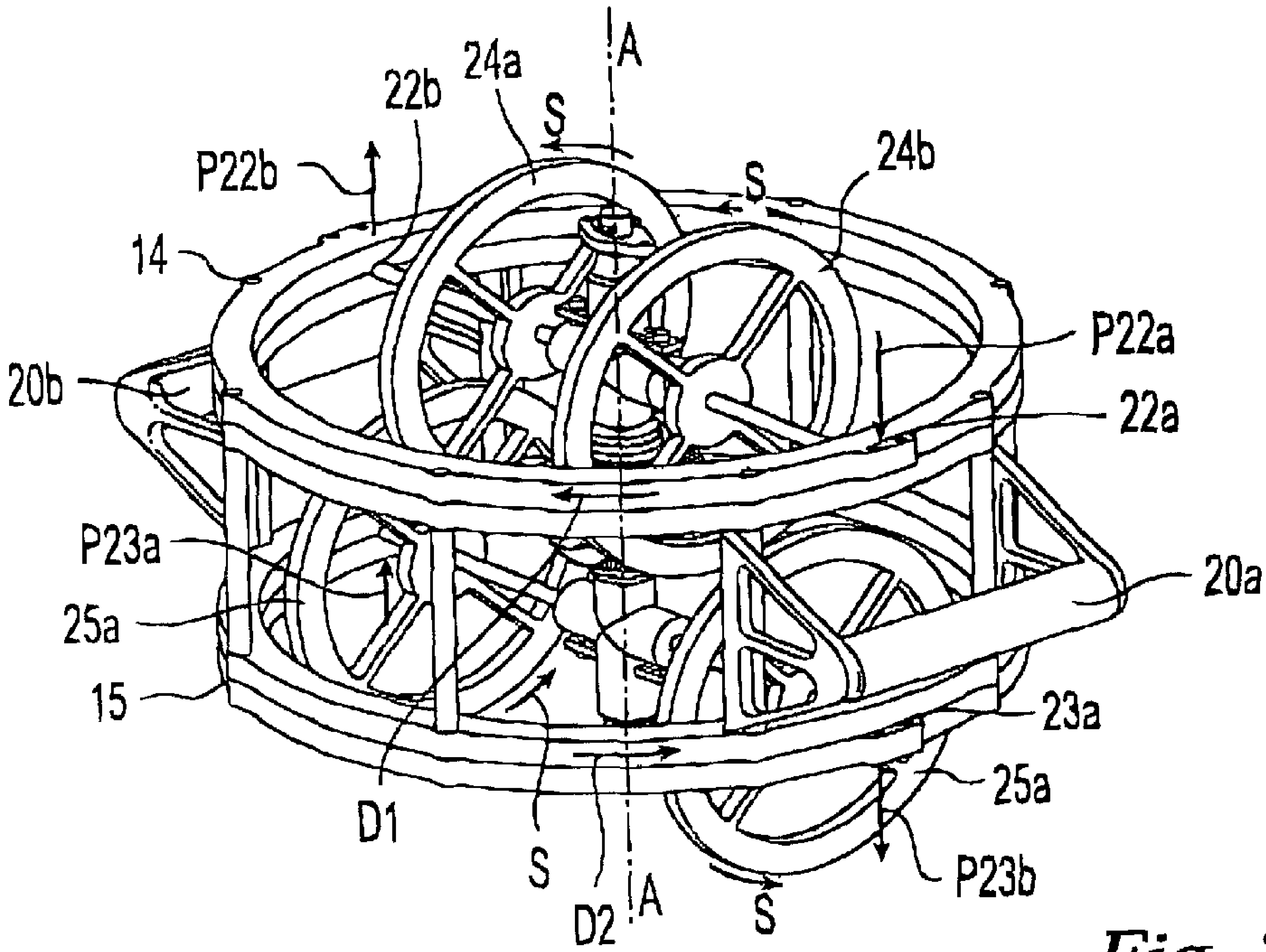

Fig. 24B

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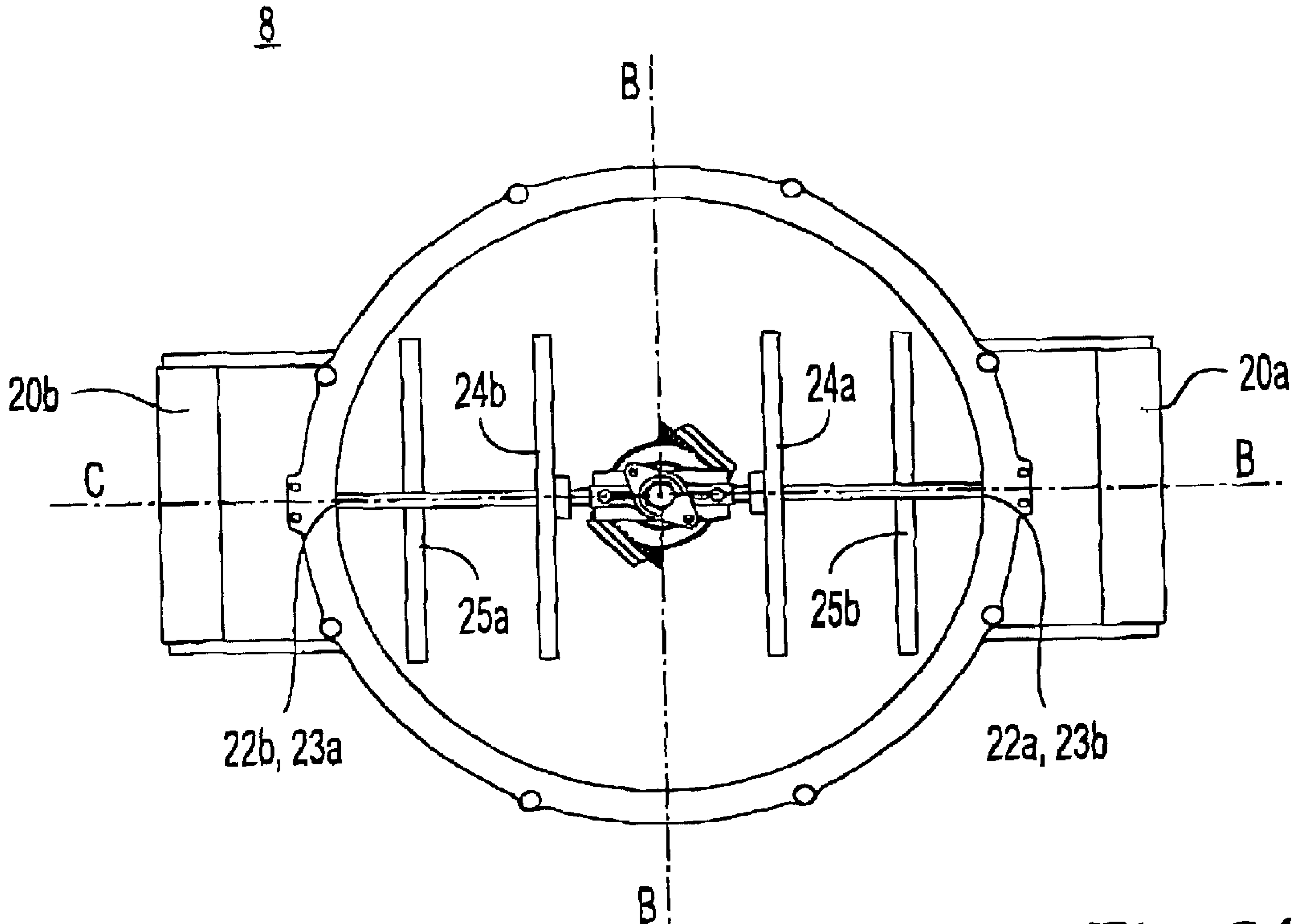

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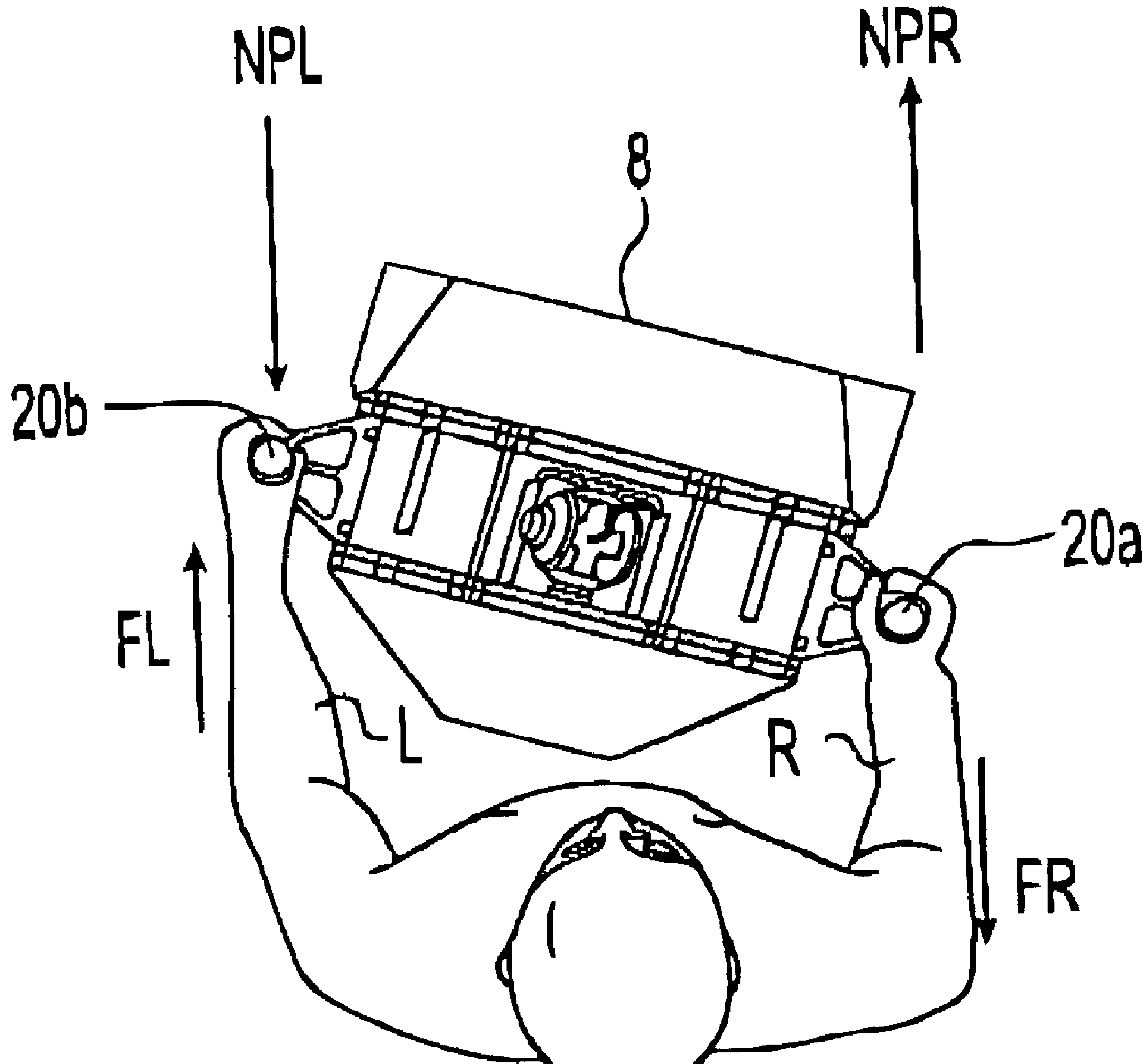

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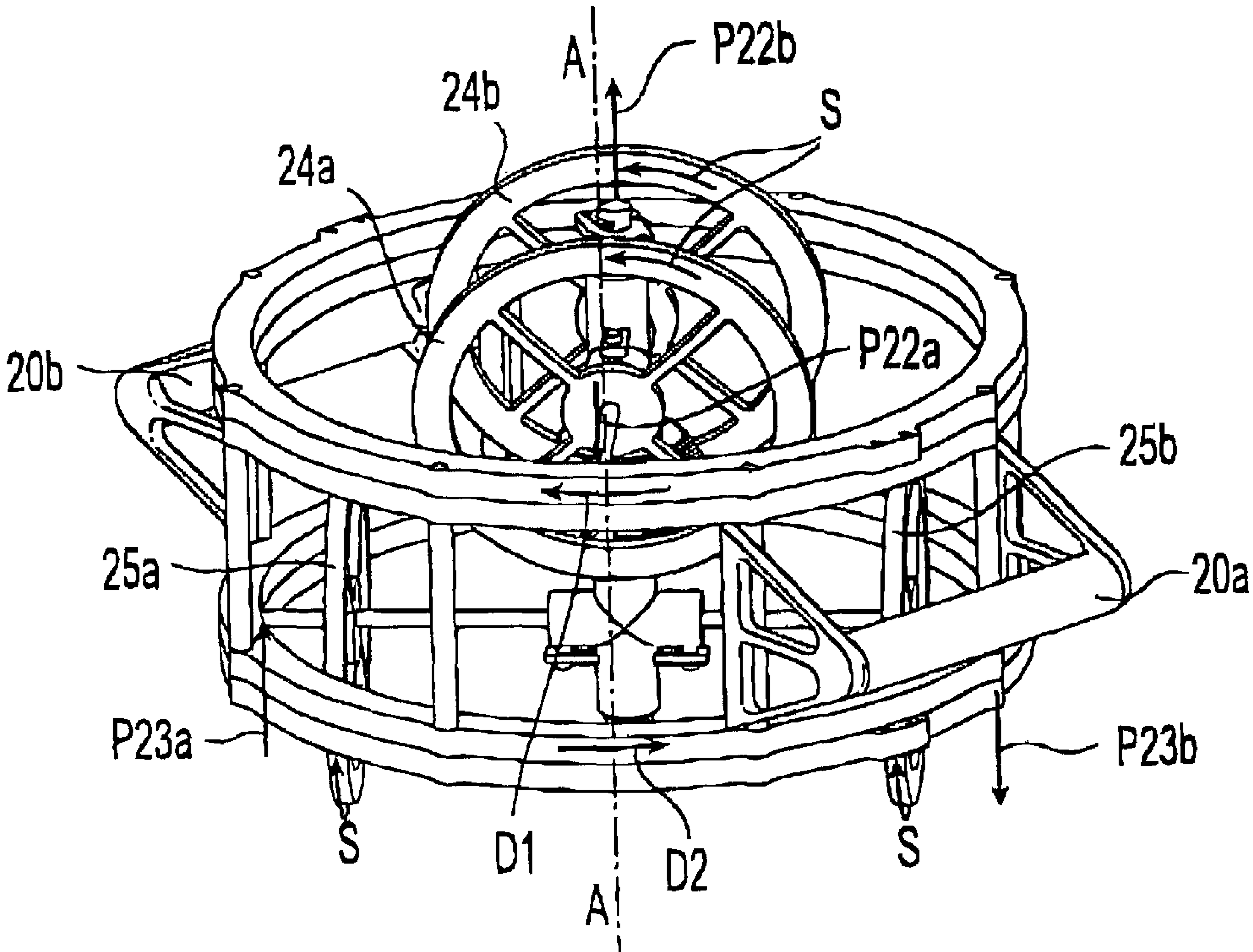

Fig. 25B

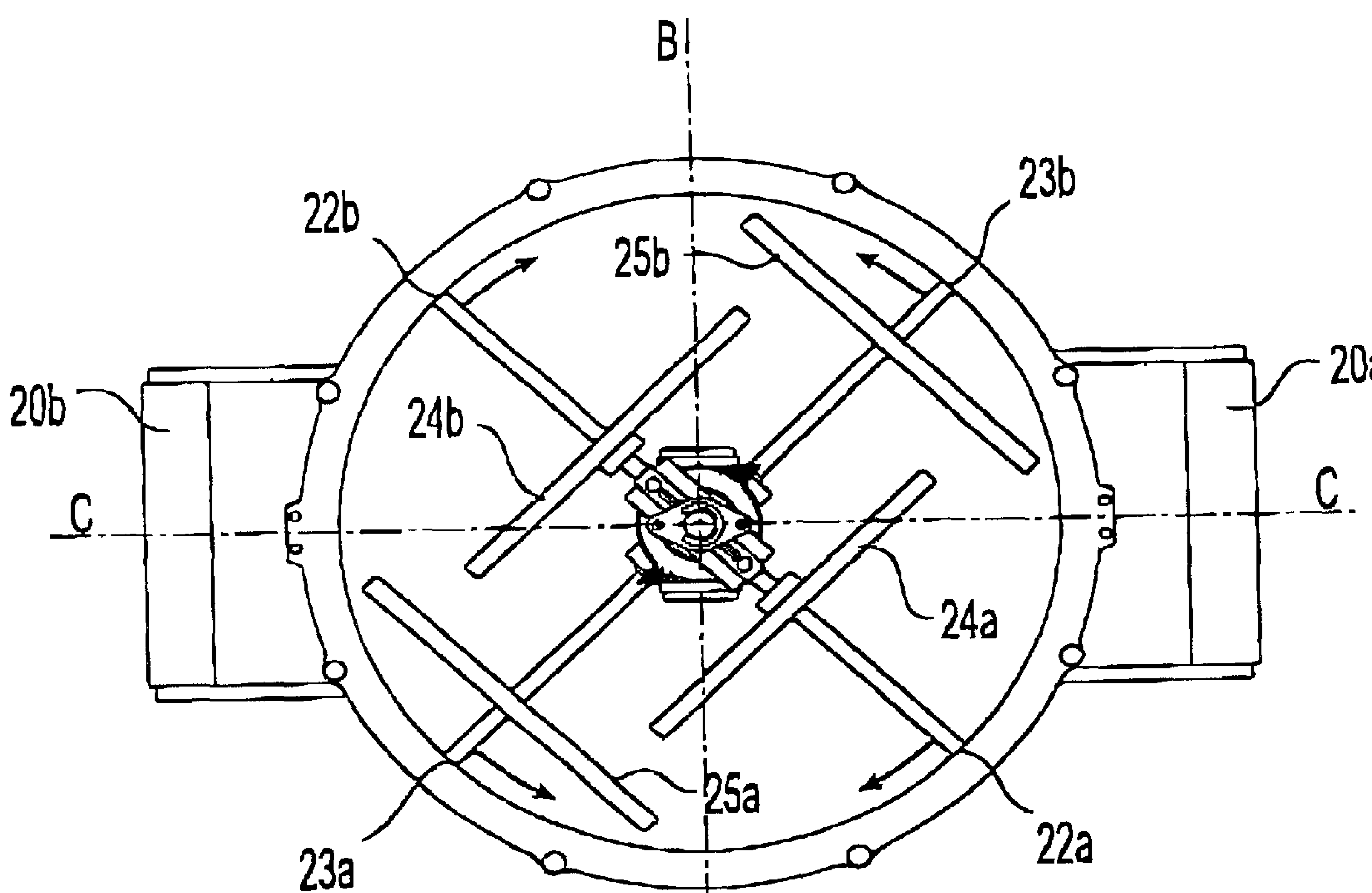

Fig. 25C

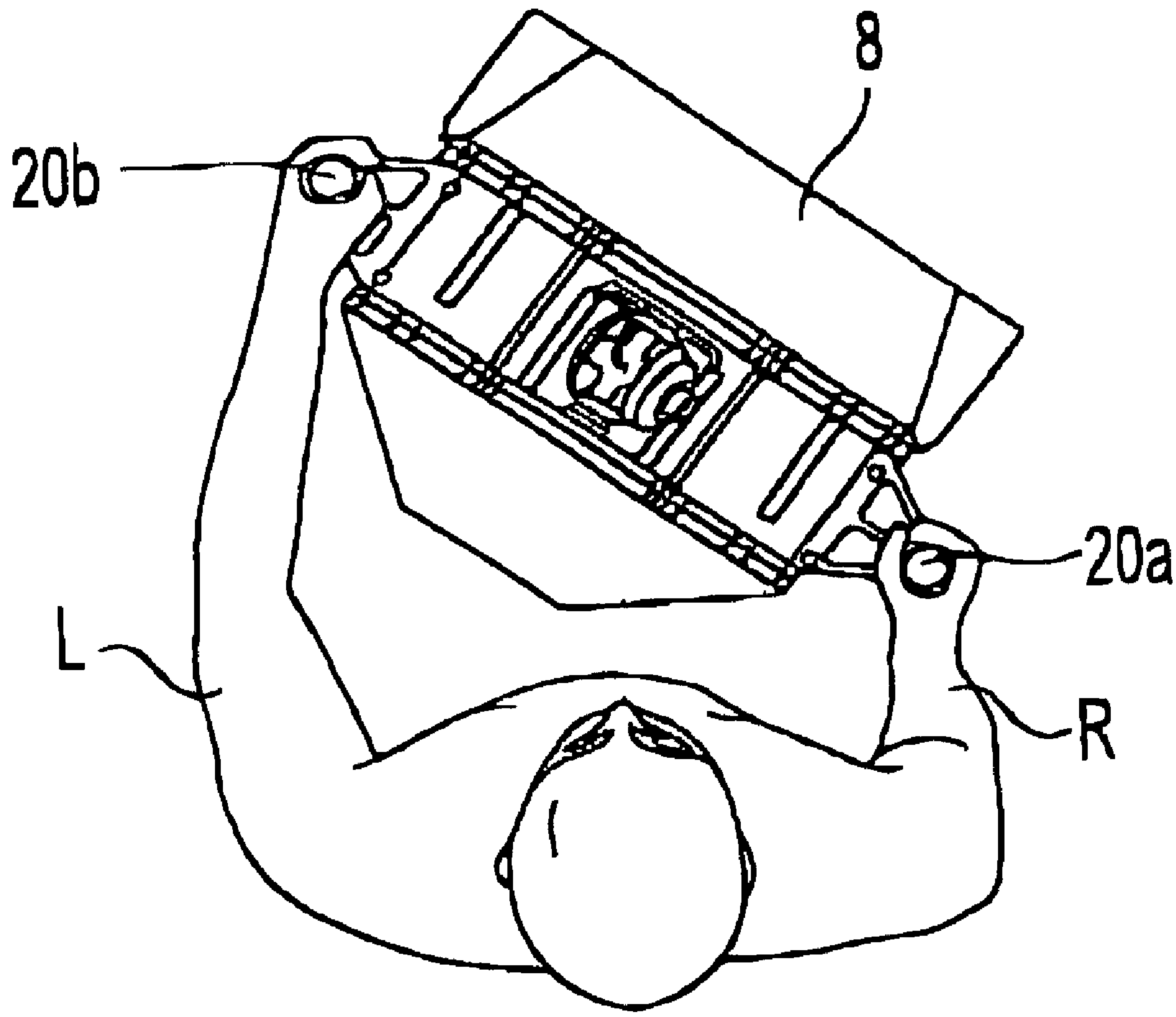

Fig. 26A

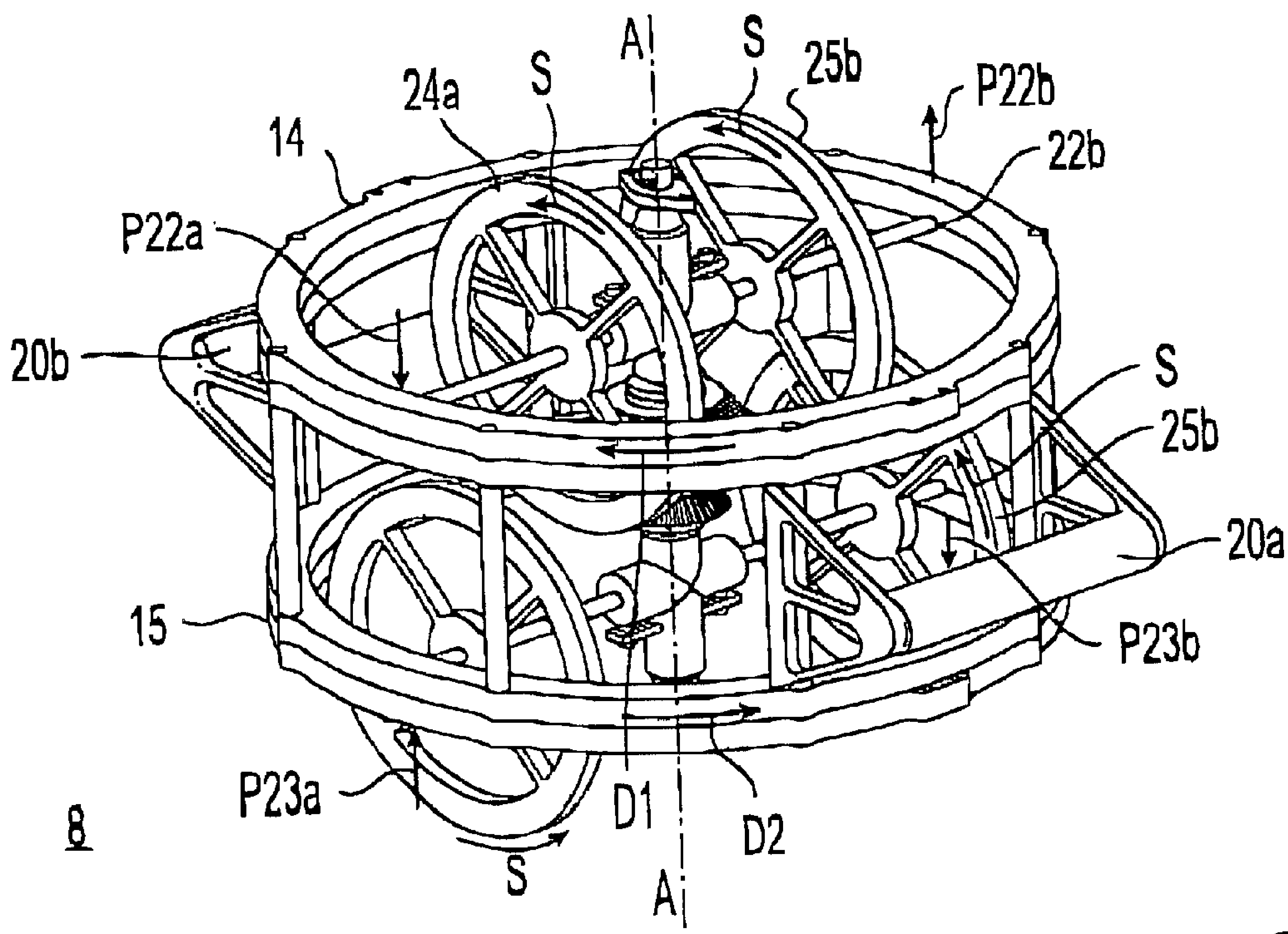

Fig. 26B

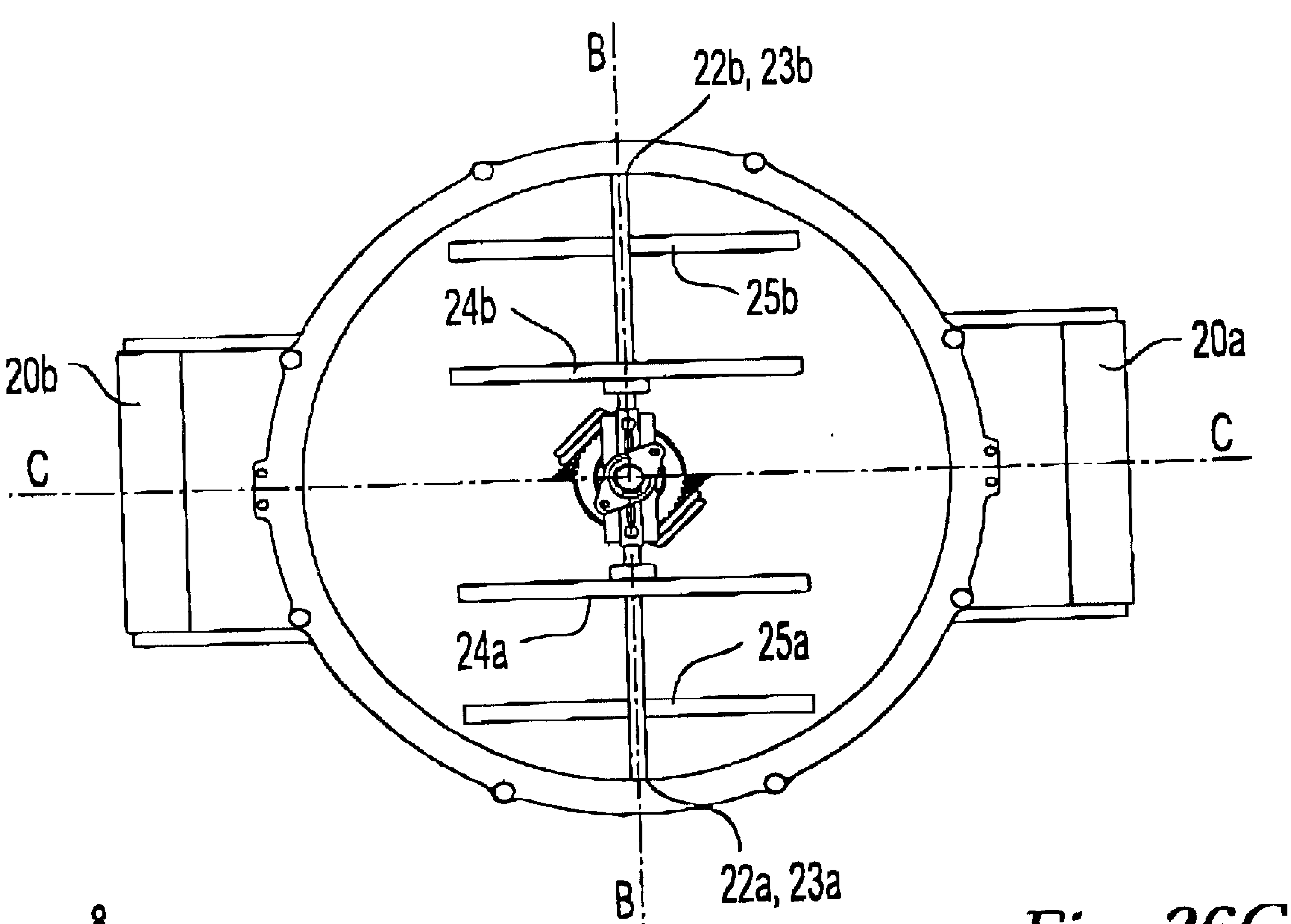

Fig. 26C

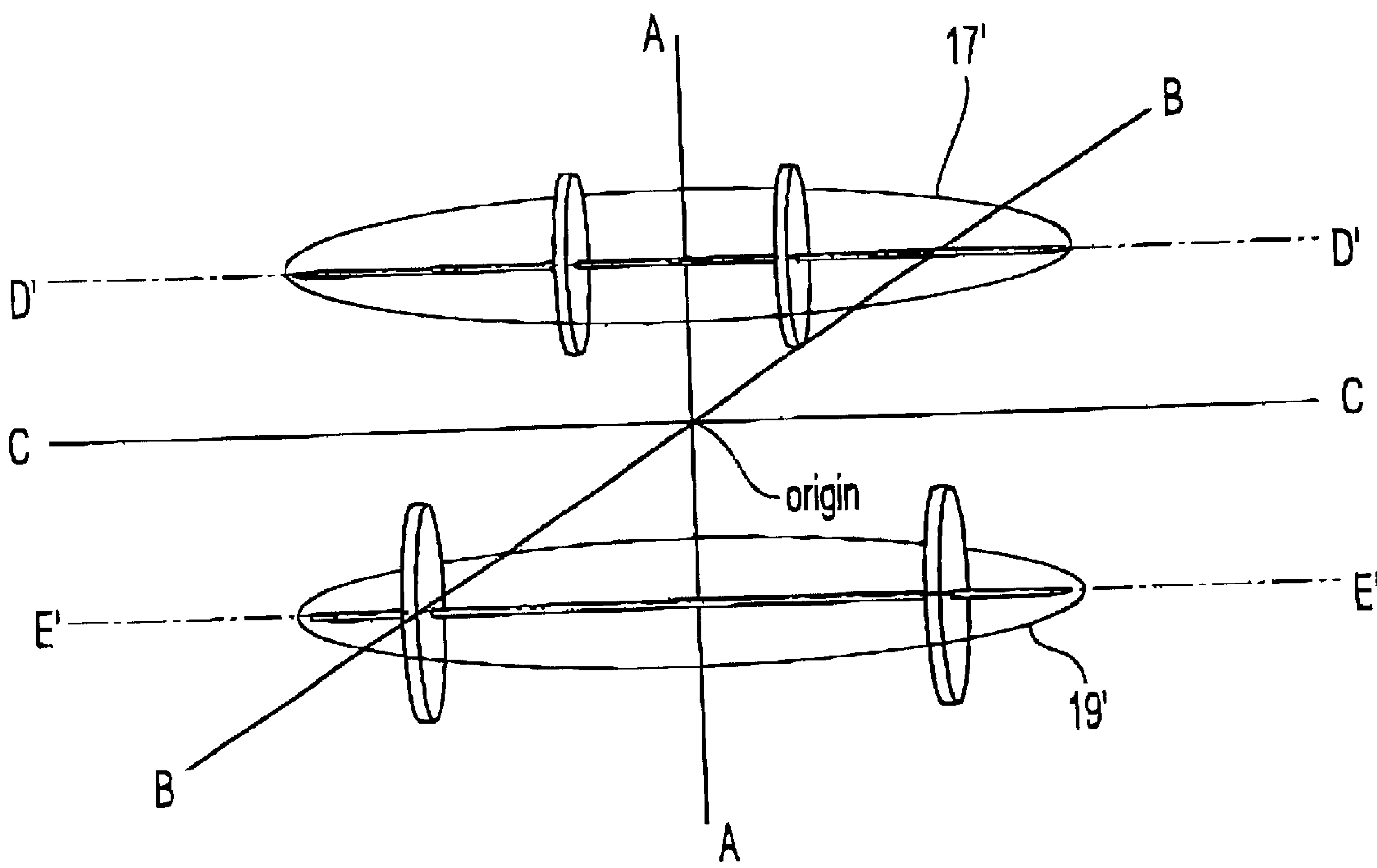

Fig. 27A

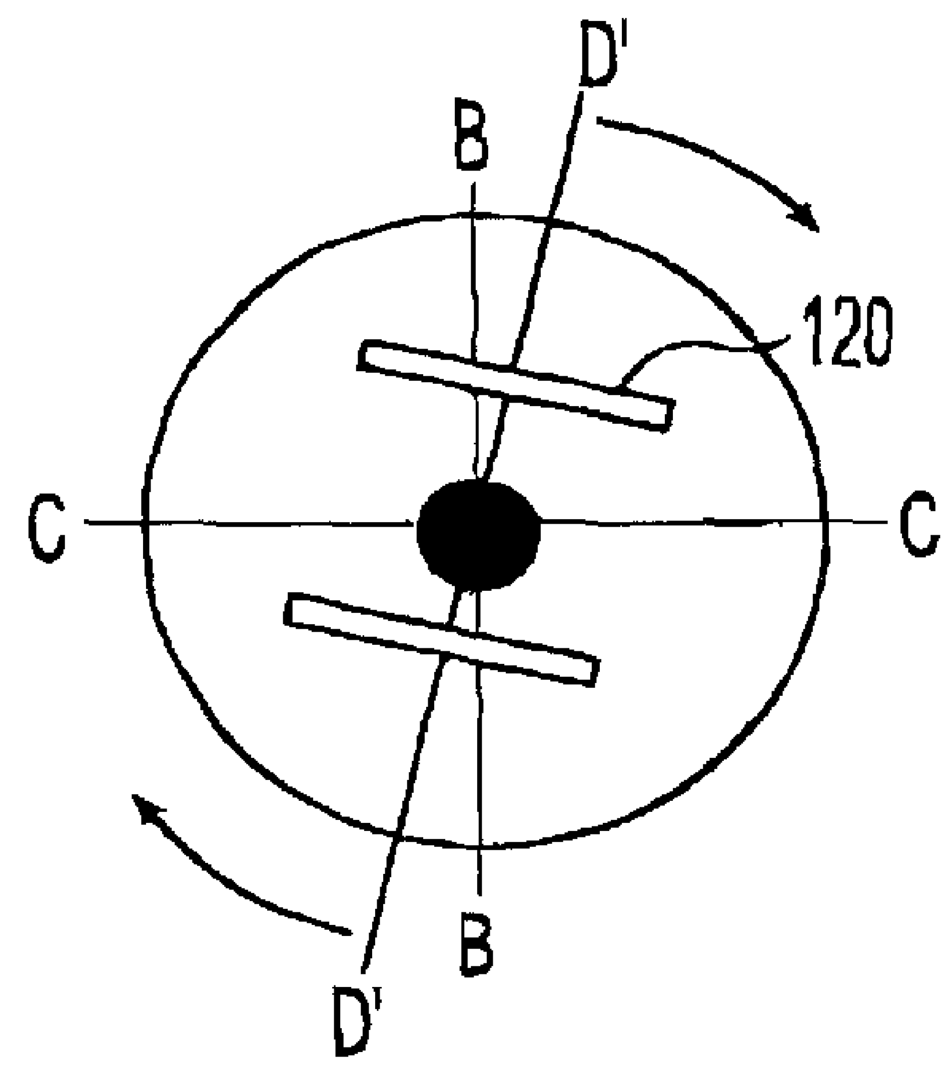

Fig. 27B

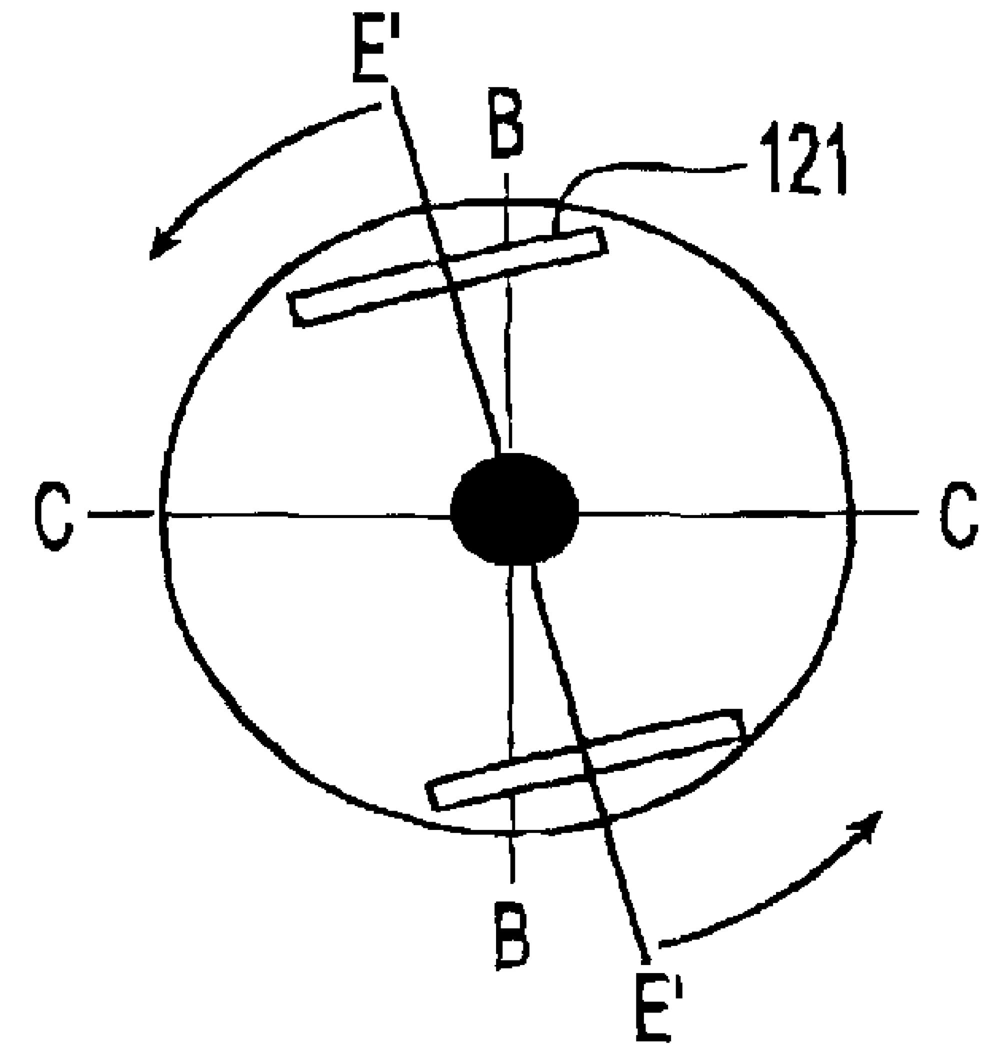

Fig. 27C

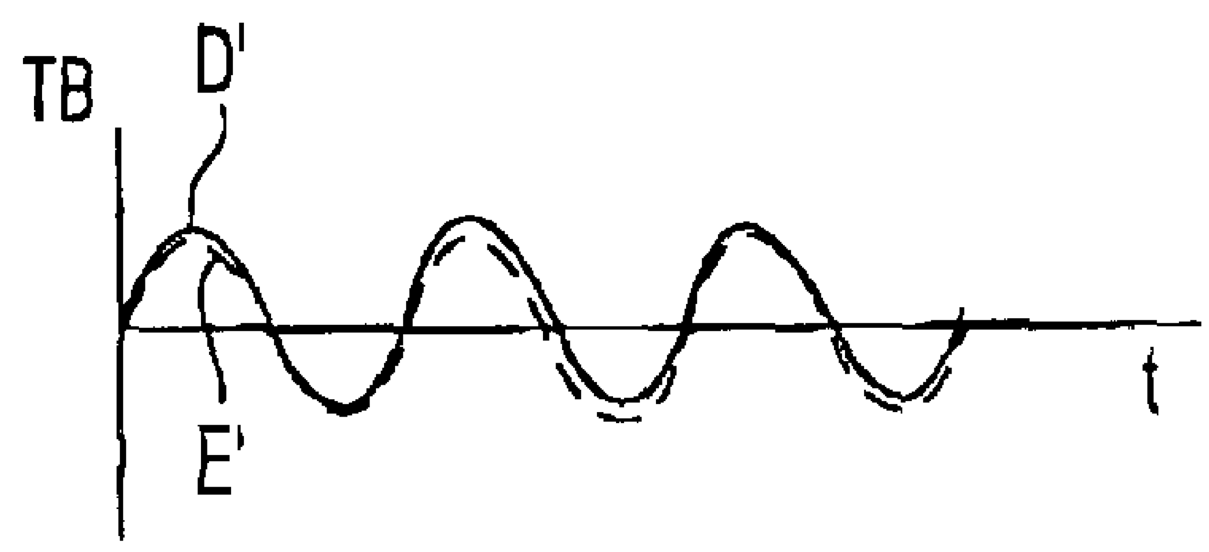

Fig. 27D

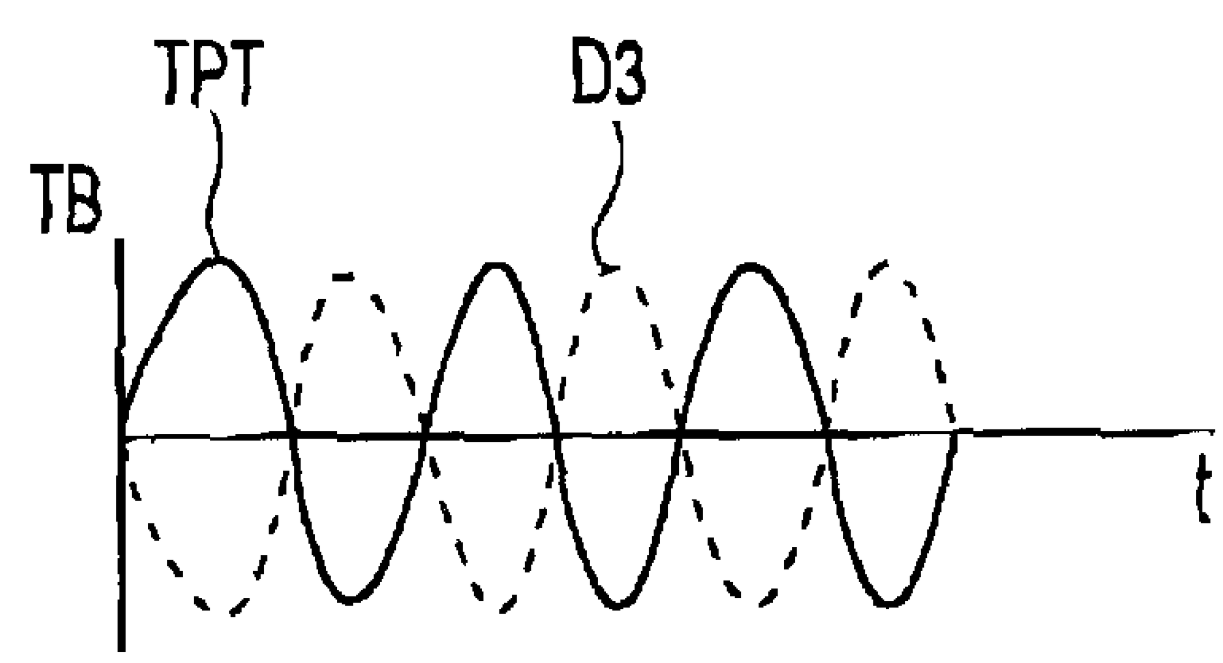

Fig. 27E

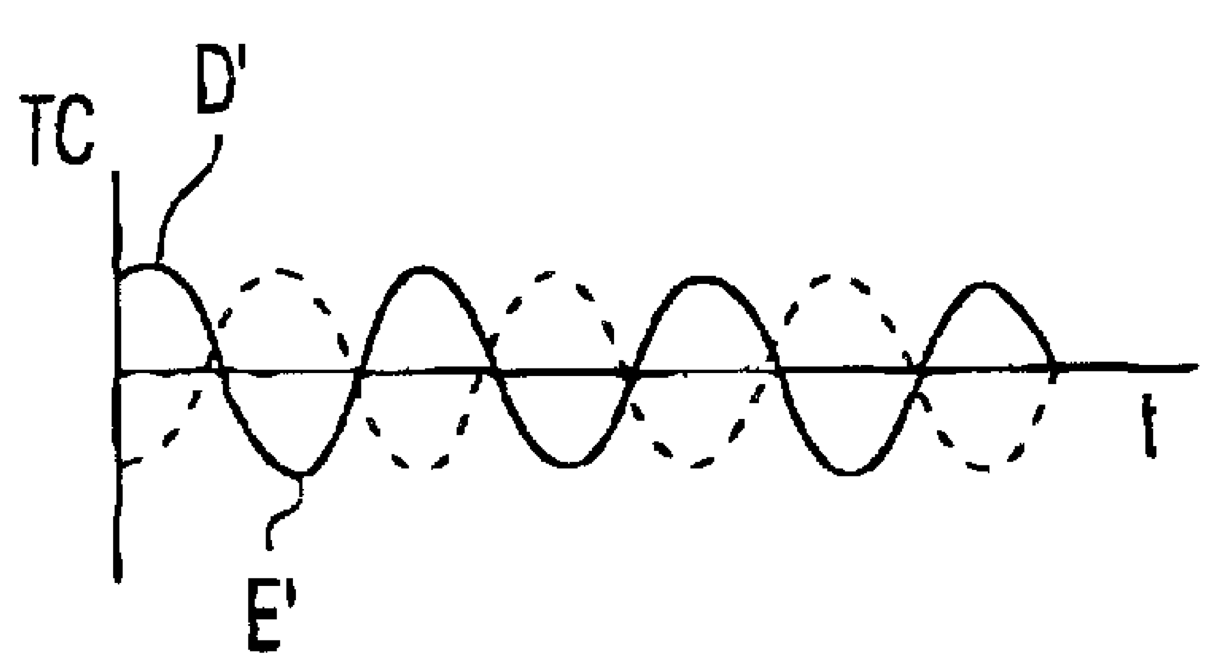

Fig. 27F

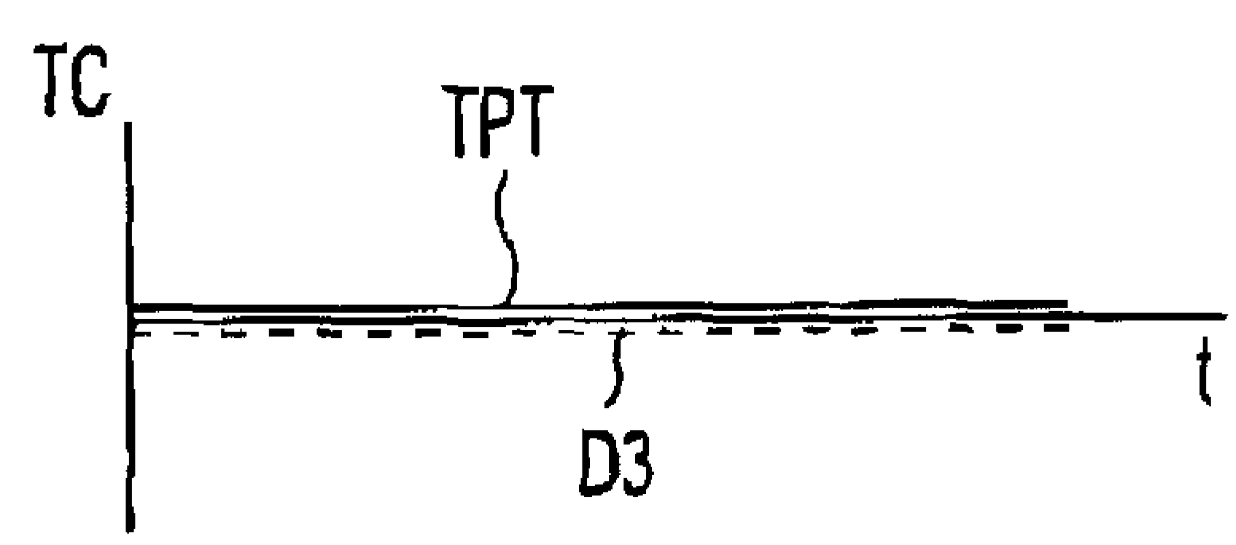

Fig. 27G

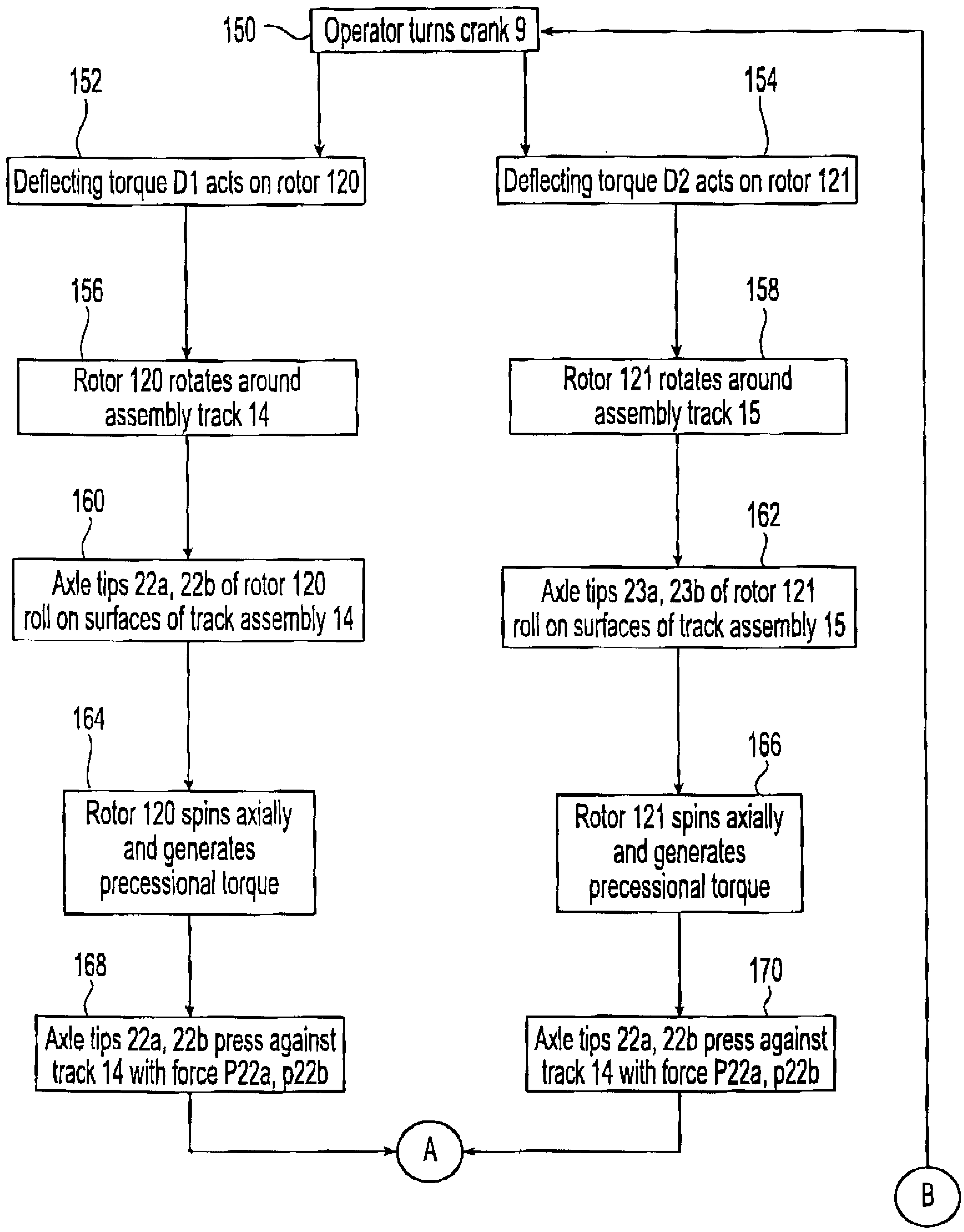
150
Operator turns crank 9
152
Deflecting torque D1 acts on rotor 120
154
Deflecting torque D2 acts on rotor 121
156
Rotor 120 rotates around assembly track 14
158
Rotor 121 rotates around assembly track 15
160
Axle tips 22a, 22b of rotor 120 roll on surfaces of track assembly 14
162
Axle tips 23a, 23b of rotor 121 roll on surfaces of track assembly 15
164
Rotor 120 spins axially and generates precessional lorque
166
Rotor 121 spins axially and generates precessional torque
168
Axle tips 22a, 22b press against track 14 with force P22a, p22b
170
Axle tips 22a, 22b press against track 14 with force P22a, p22b
A
B

Fig. 27H

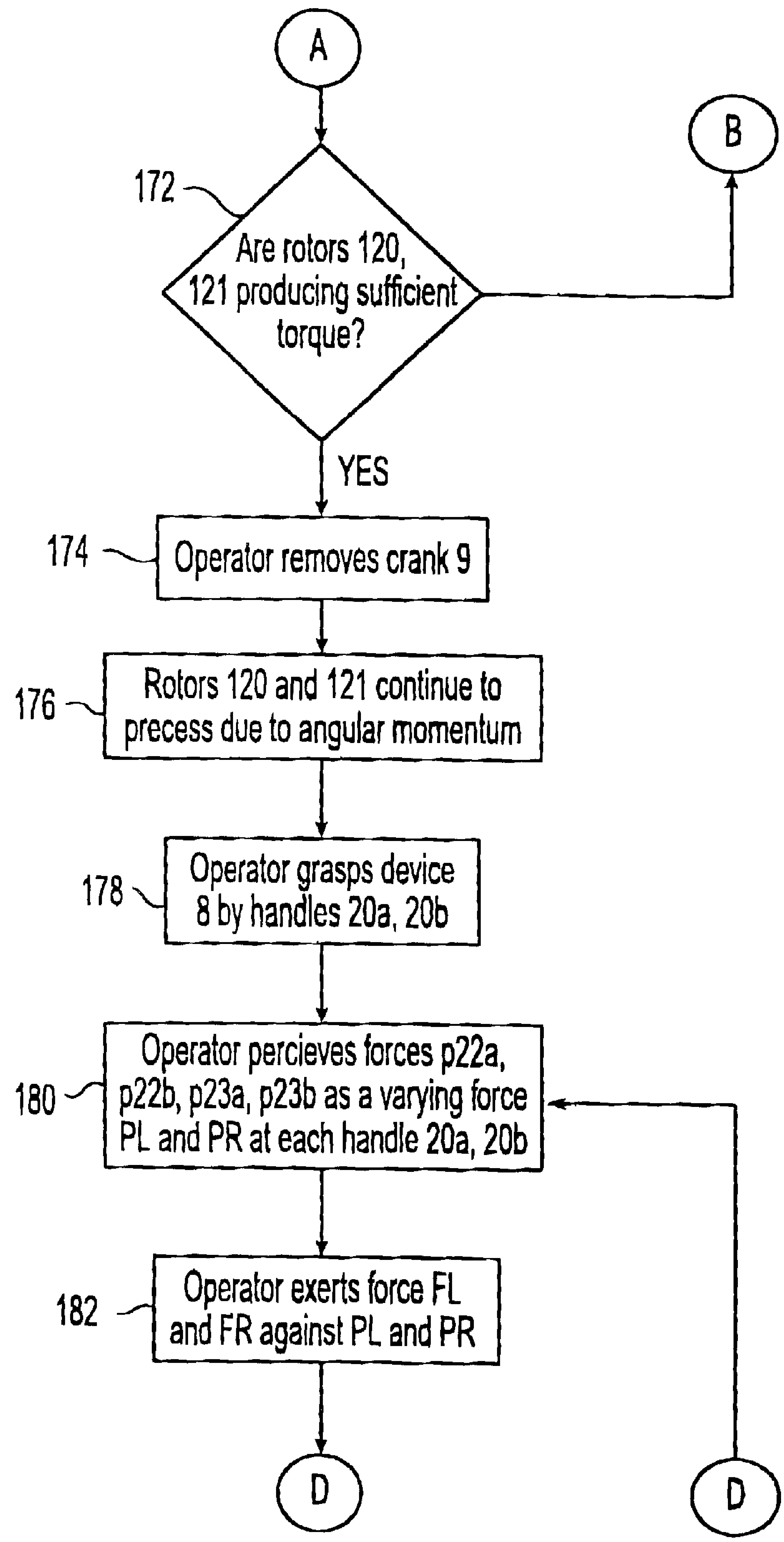
A
B
172
Are rotors 120, 121 producing sufficient torque?
YES
174
Operator removes crank 9
176
Rotors 120 and 121 continue to precess due to angular momentum
178
Operator grasps device 8 by handles 20a, 20b
180
Operator percieves forces p22a, p22b, p23a, p23b as a varying force PL and PR at each handle 20a, 20b
182
Operator exerts force FL and FR against PL and PR
D
D

Fig. 27I

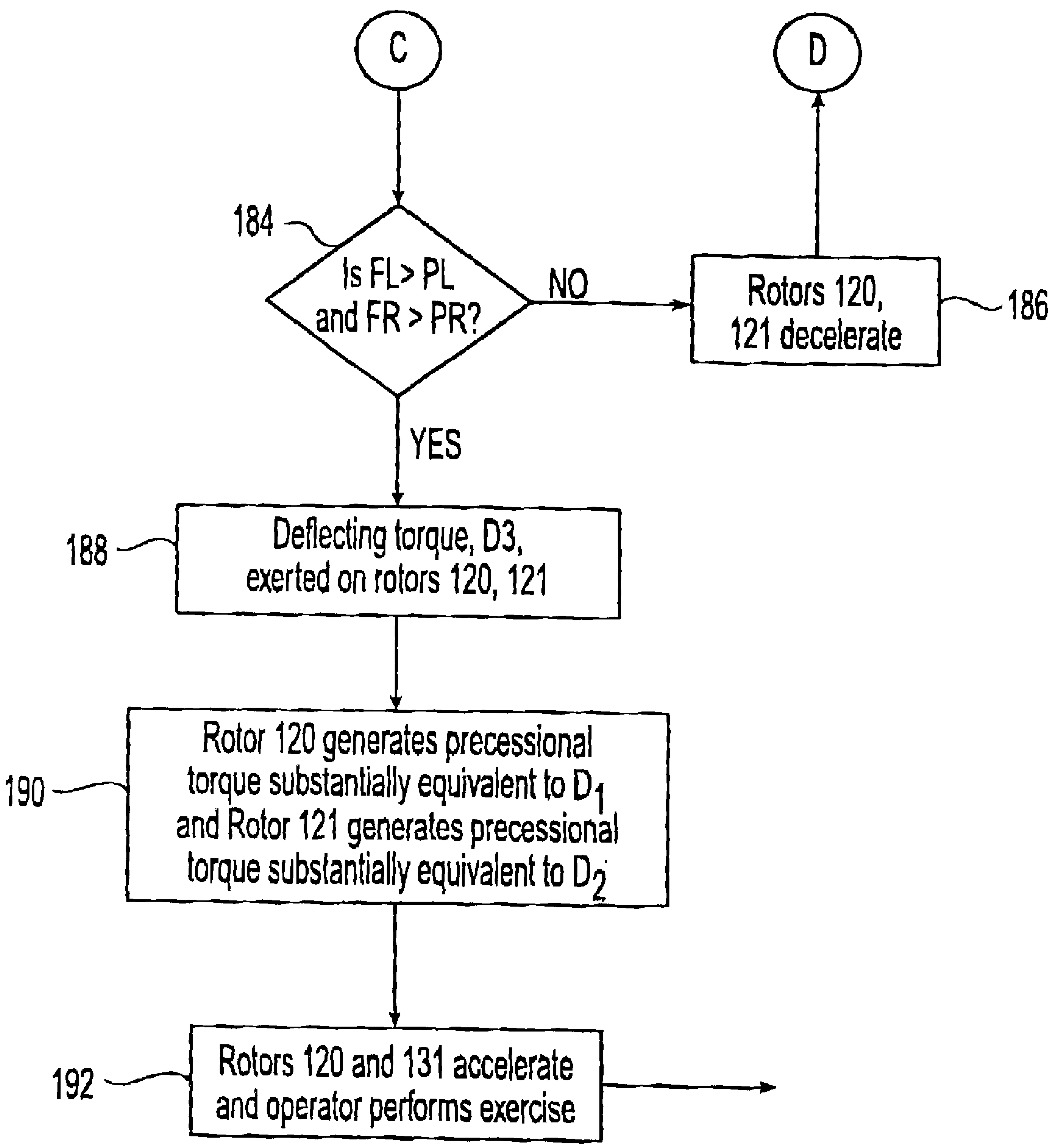
C
D
184
Is FL> PL
and FR > PR?
NO
Rotors 120,
121 decelerate
186
YES
188
Deflecting torque, D3,
exerted on rotors 120, 121
190
Rotor 120 generates precessional
torque substantially equivalent to D1
and Rotor 121 generates precessional
torque substantially equivalent to D2
192
Rotors 120 and 131 accelerate
and operator performs exercise

Fig. 27J

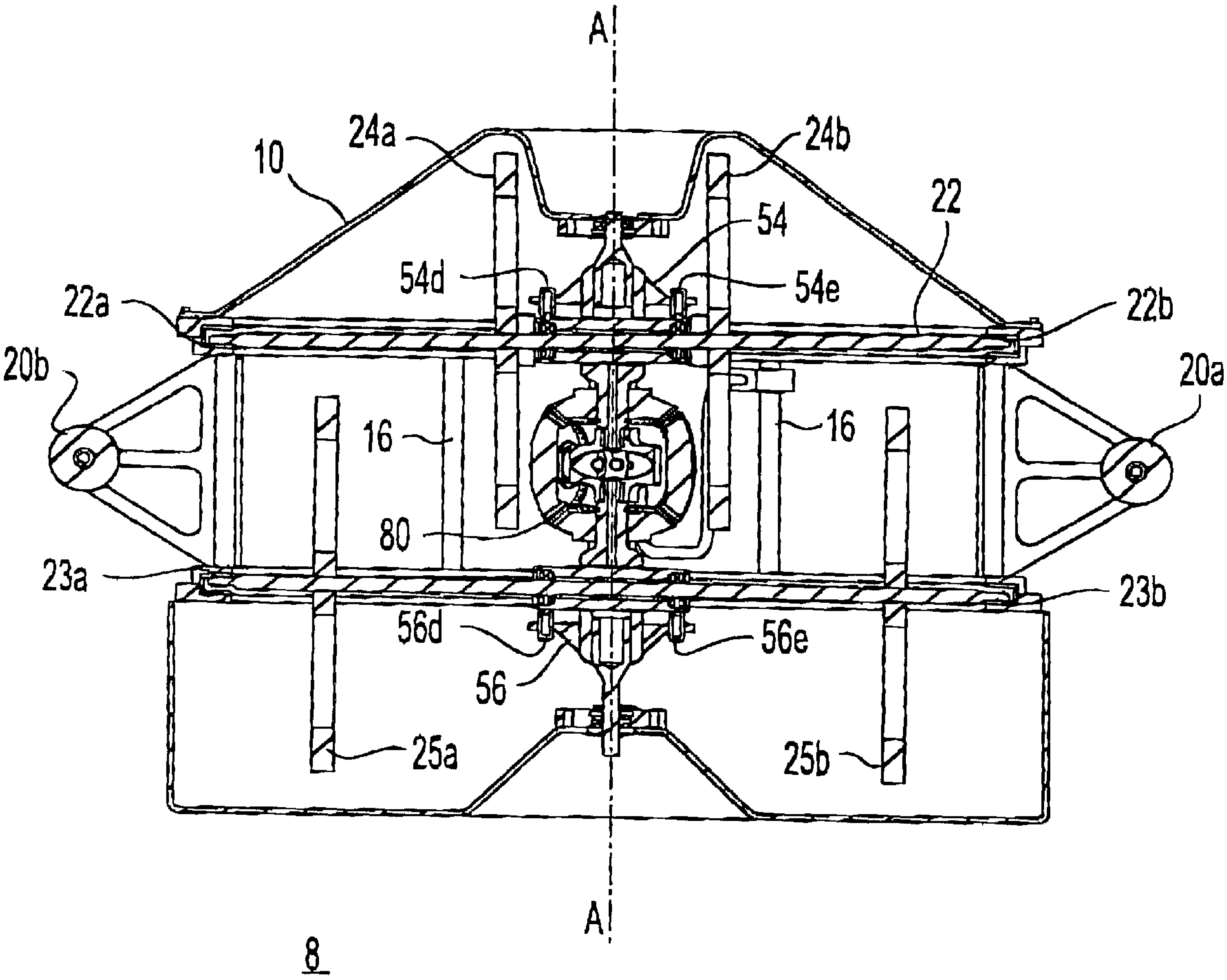
A
10
24a
24b
22
54
54d
54e
22a
22b
20b
20a
16
16
80
23a
23b
56d
56e
56
25a
25b
A
8

Fig. 28

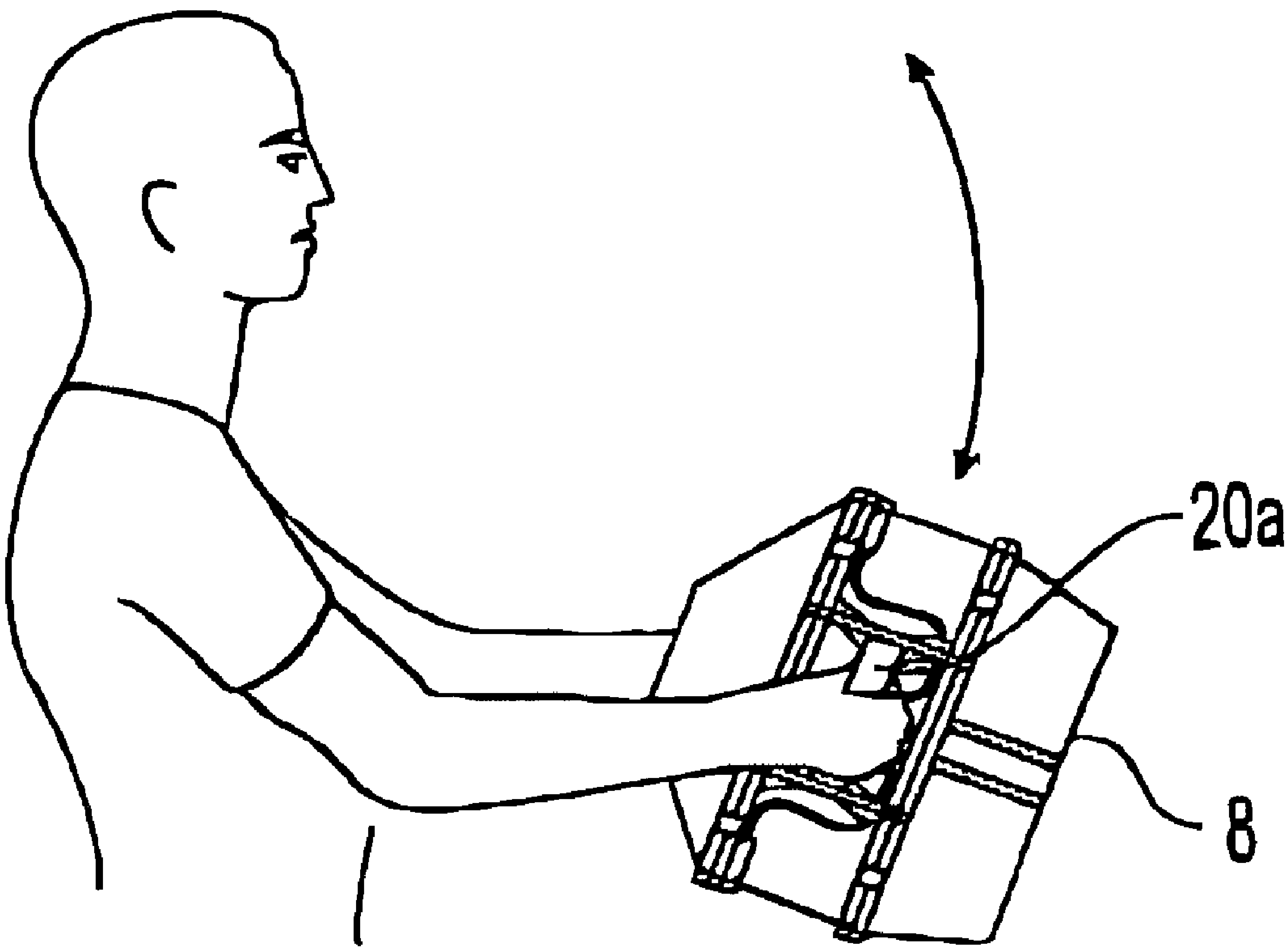

Fig. 29

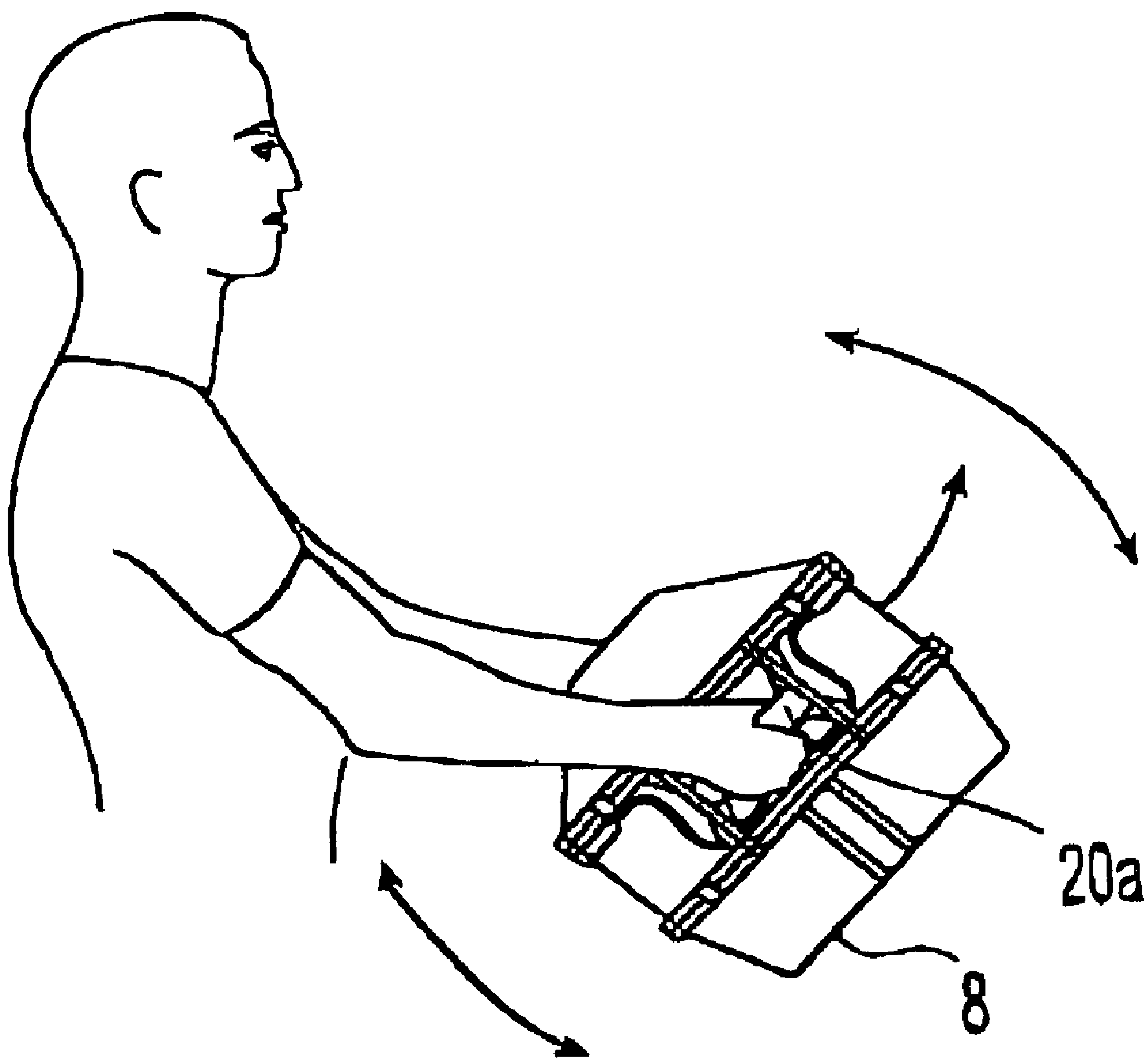

Fig. 30A

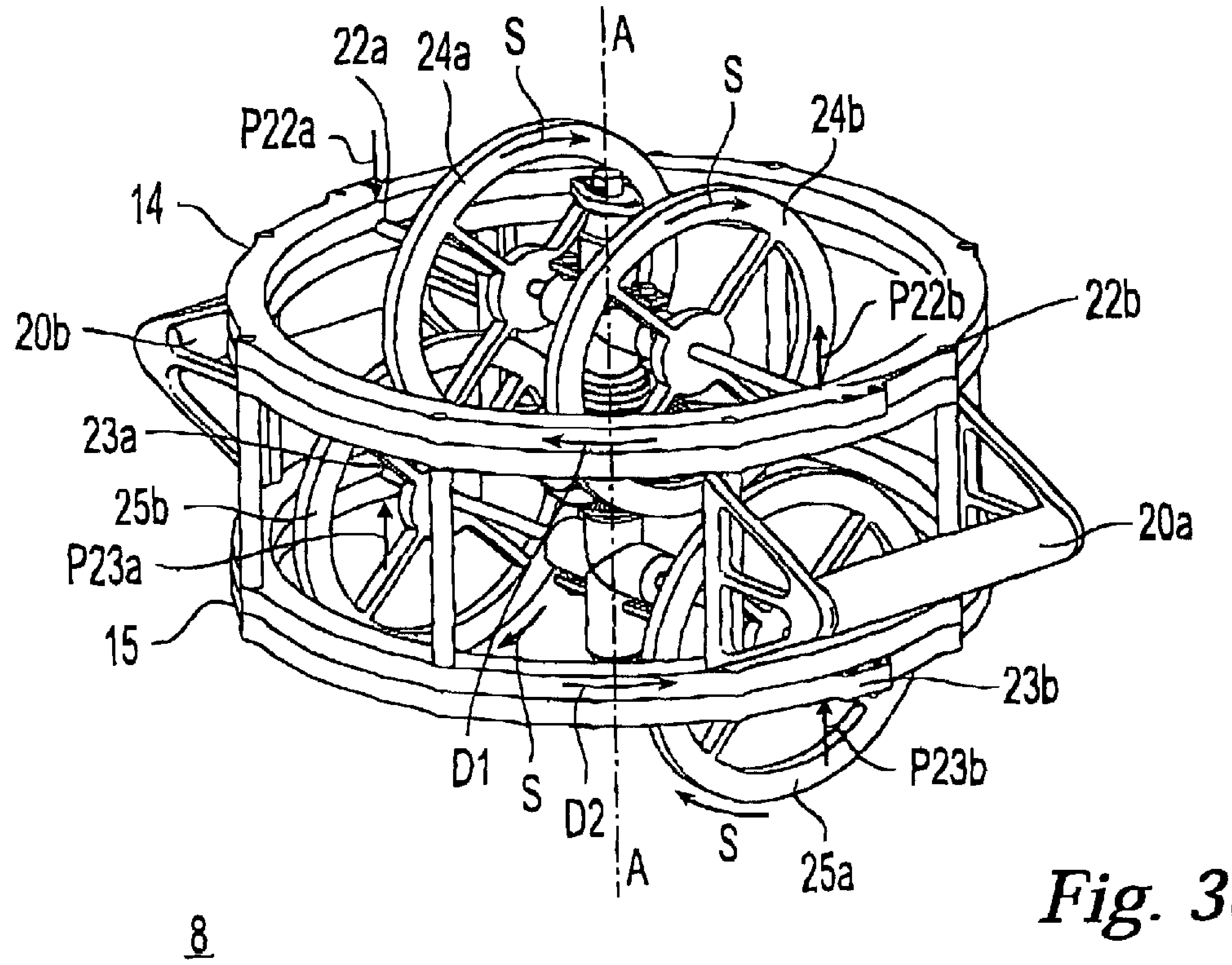

Fig. 30B

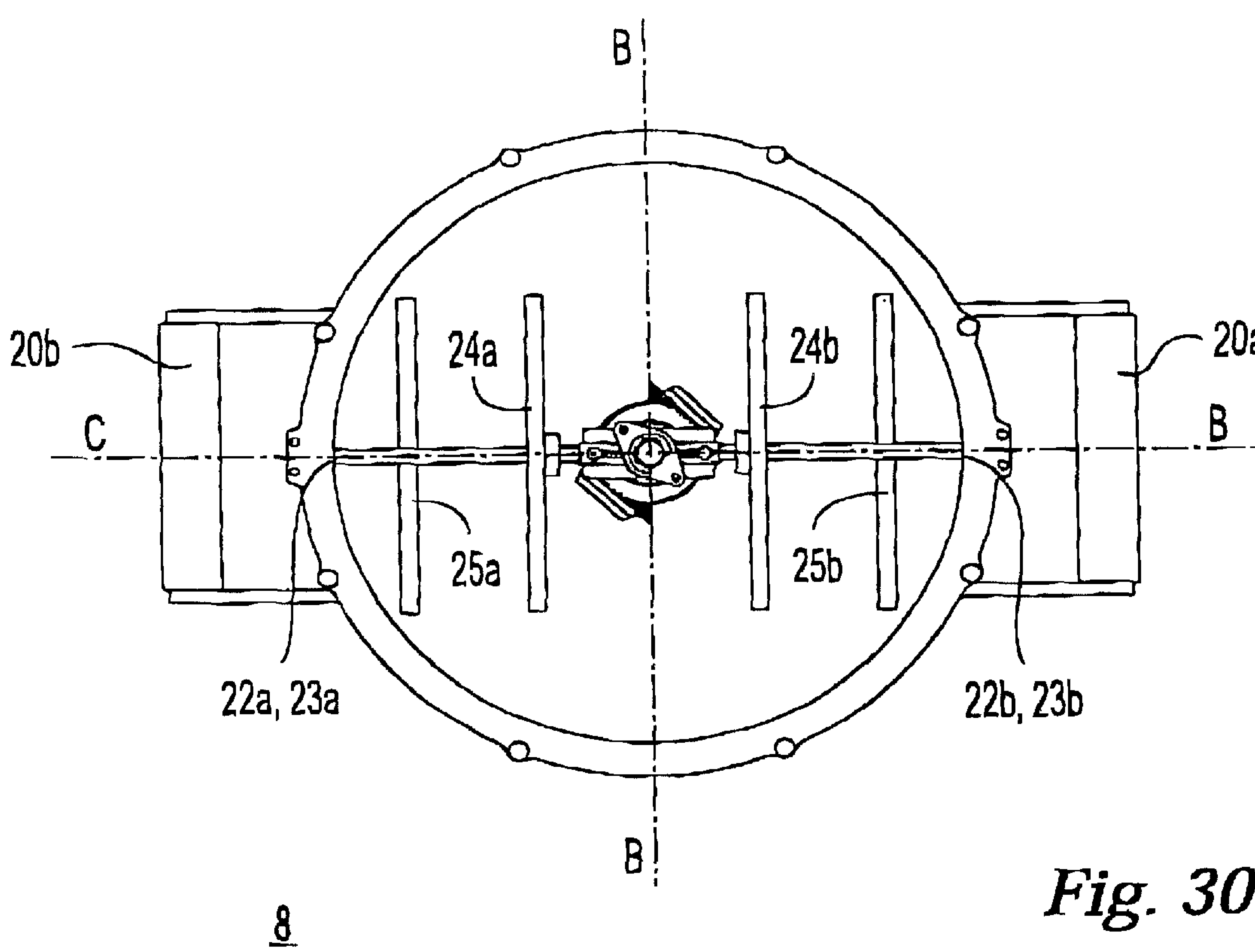

Fig. 30C

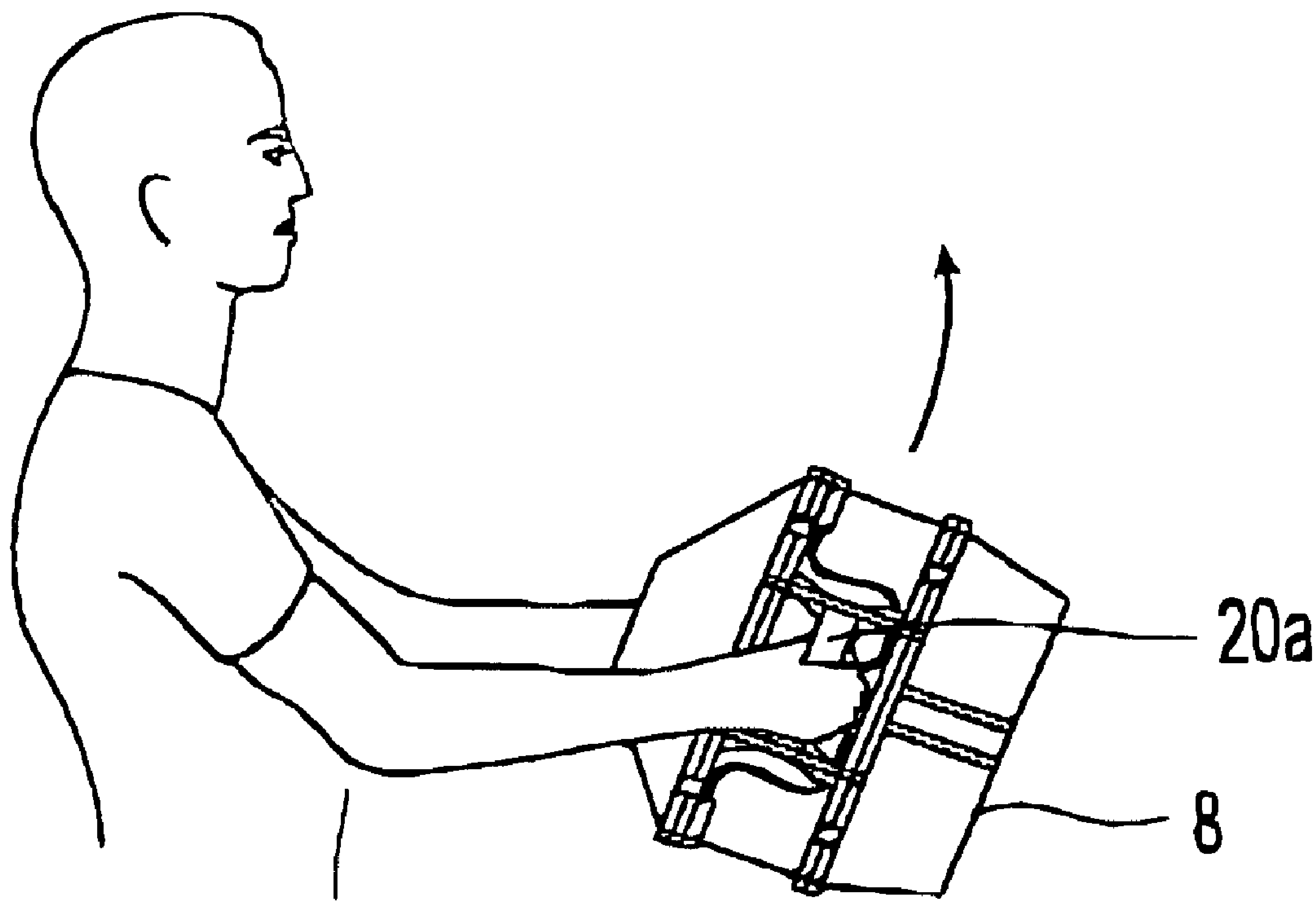

Fig. 31A

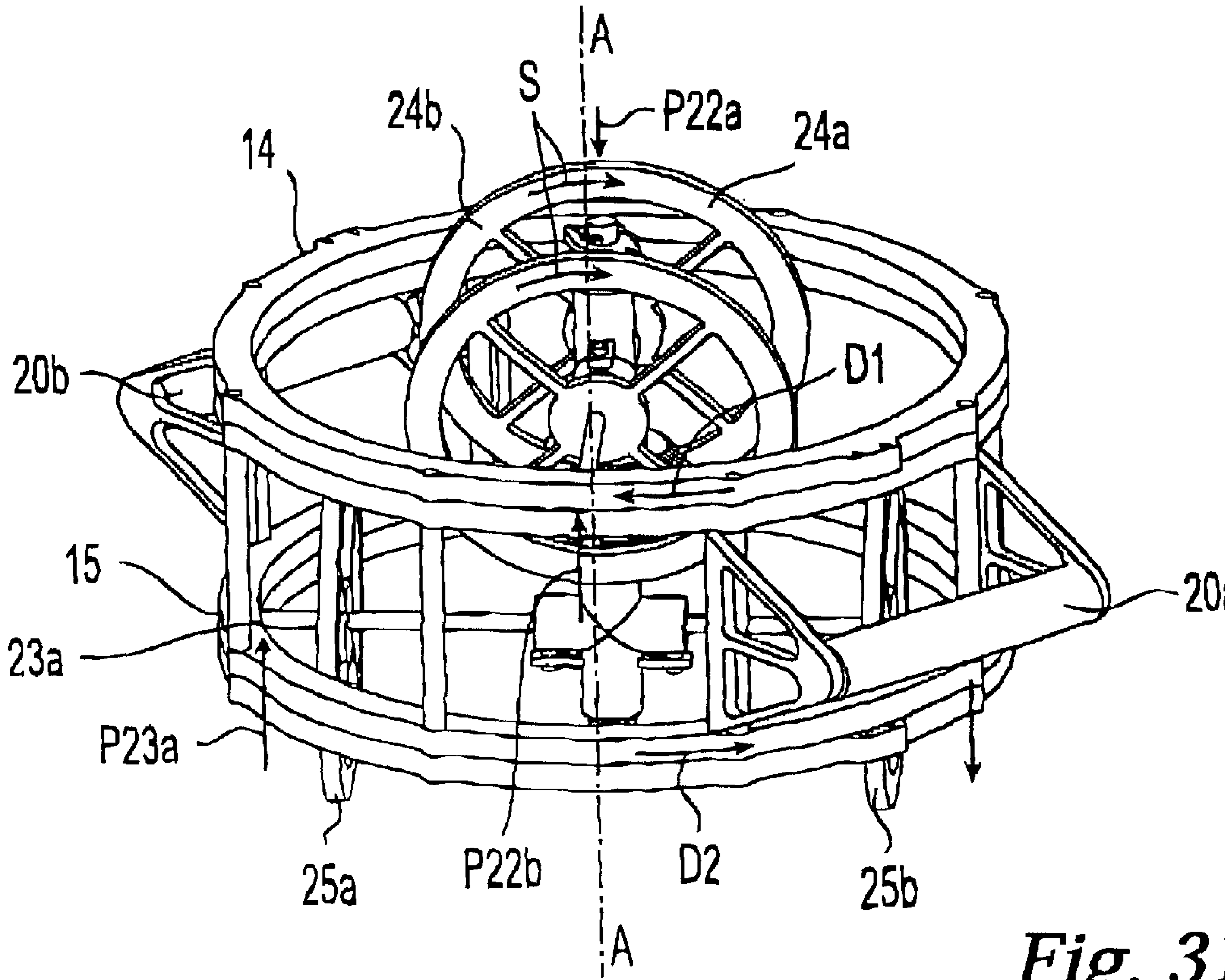

Fig. 31B

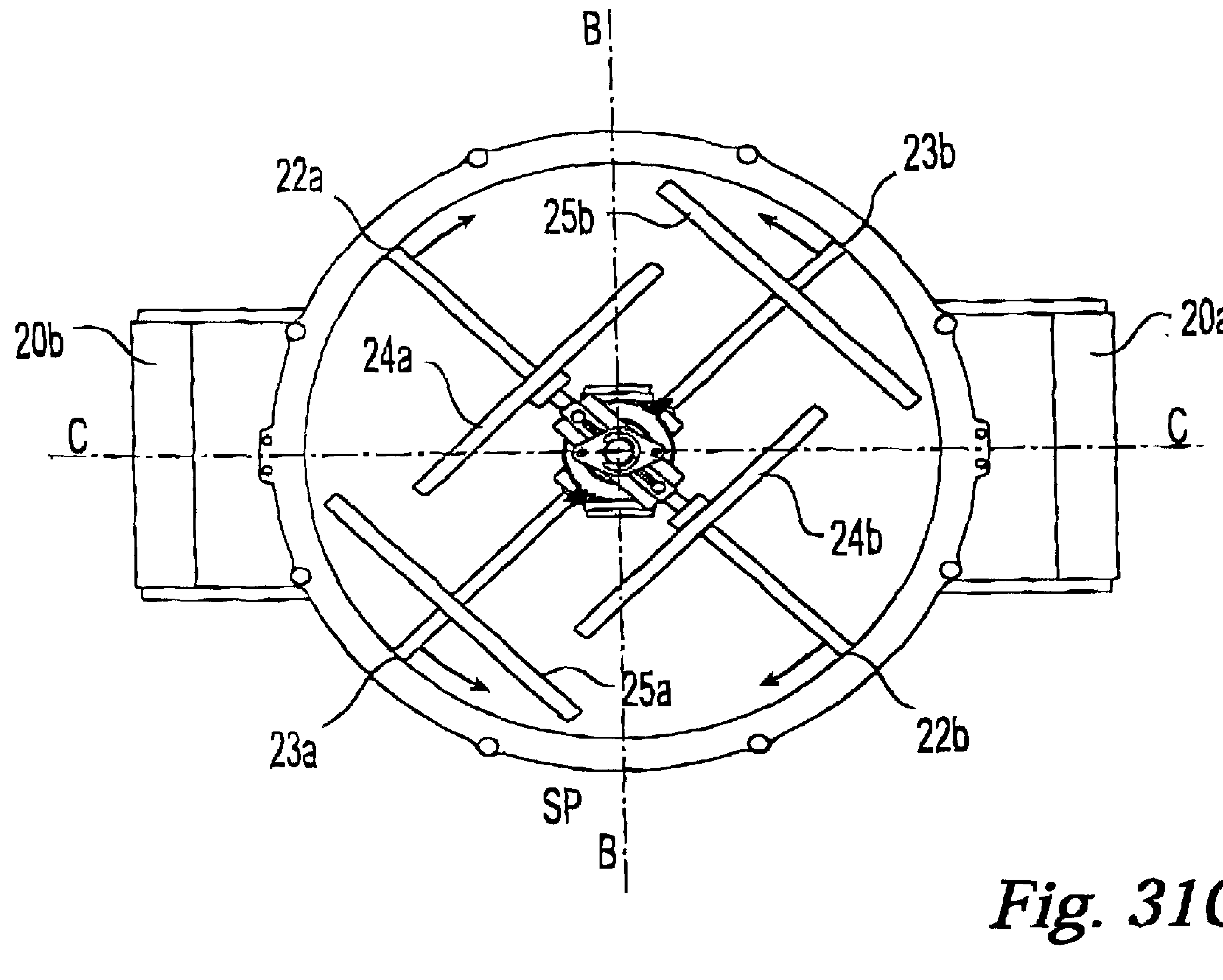

Fig. 31C

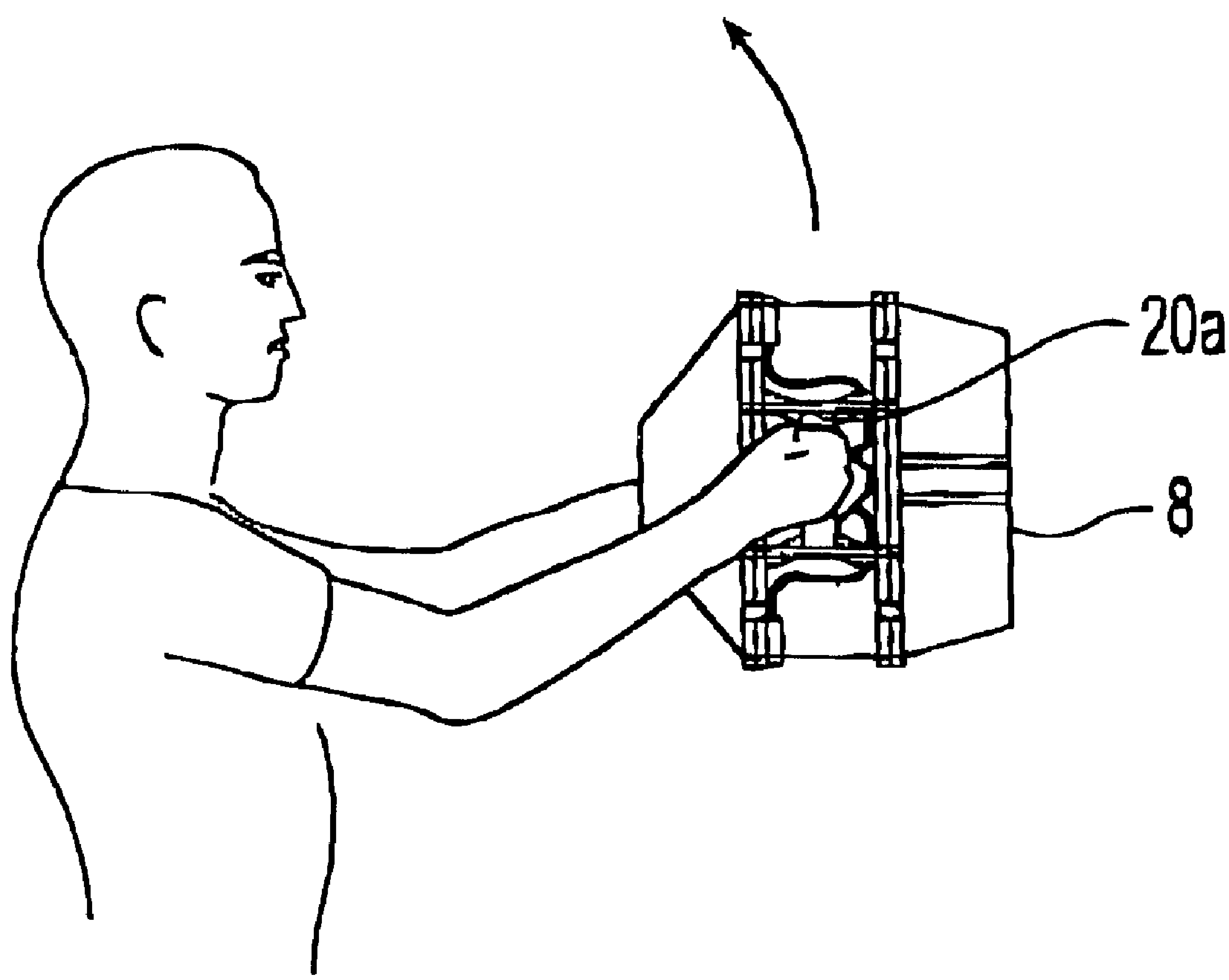

Fig. 32A

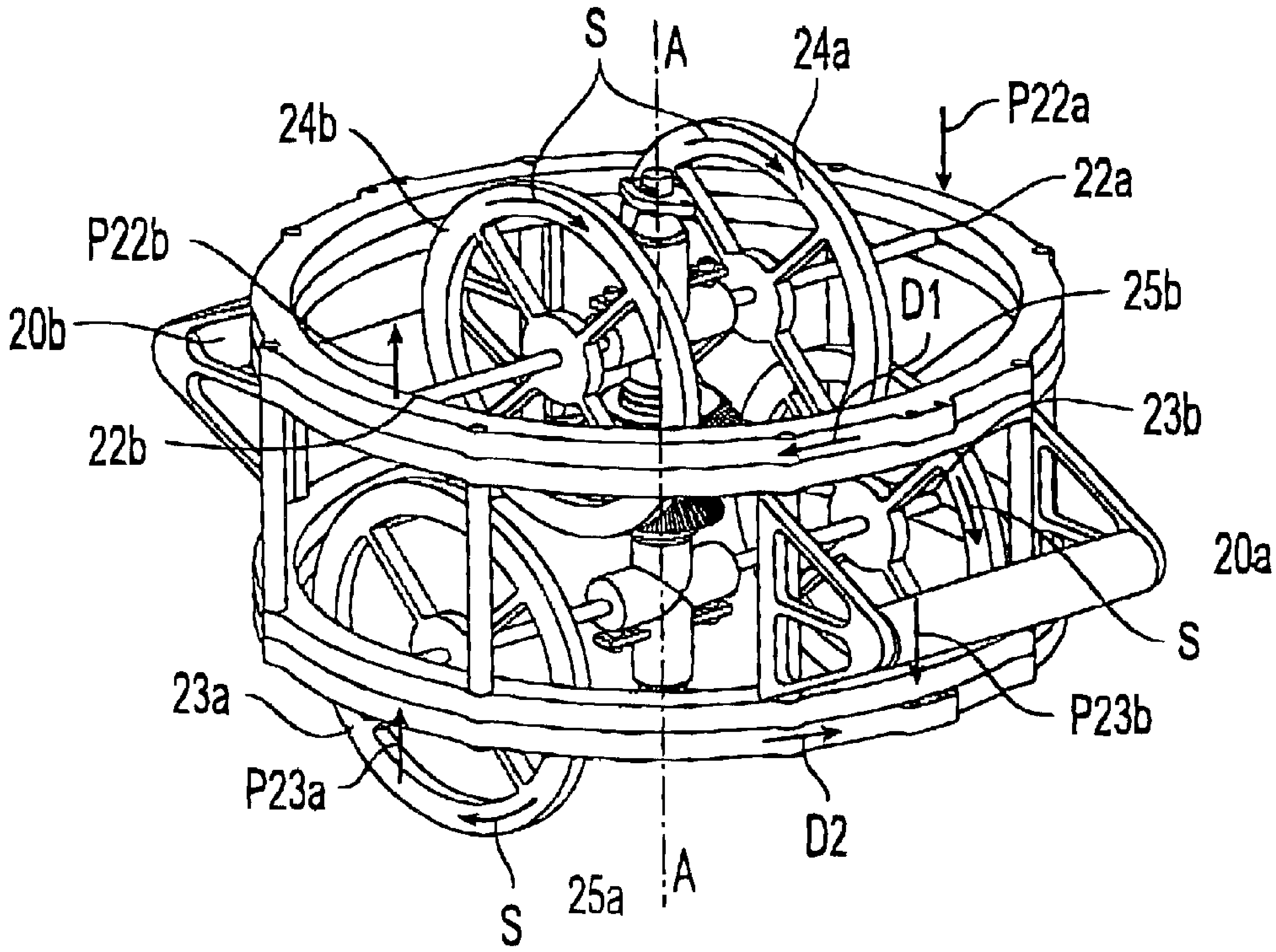

Fig. 32B

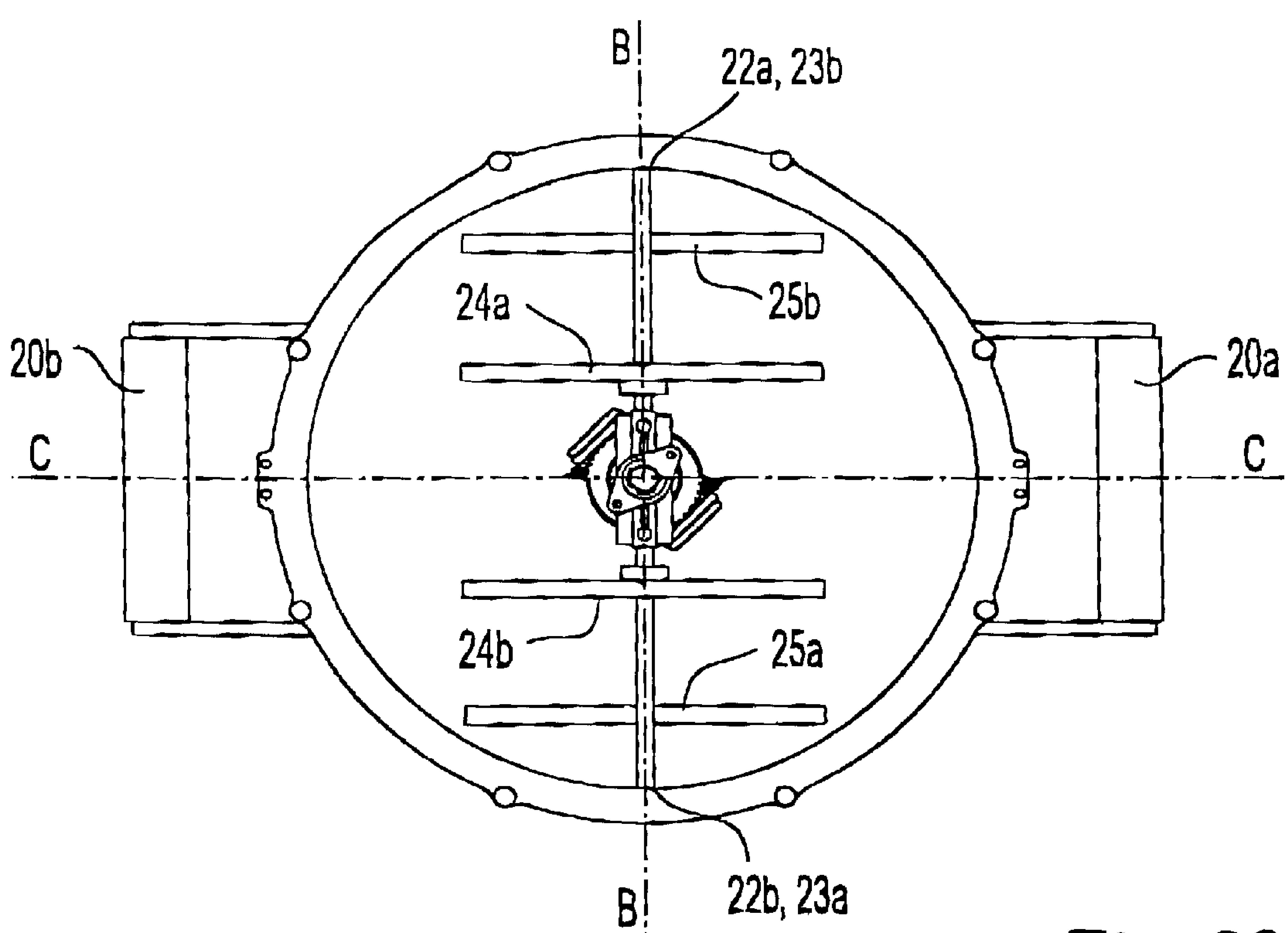

Fig. 32C

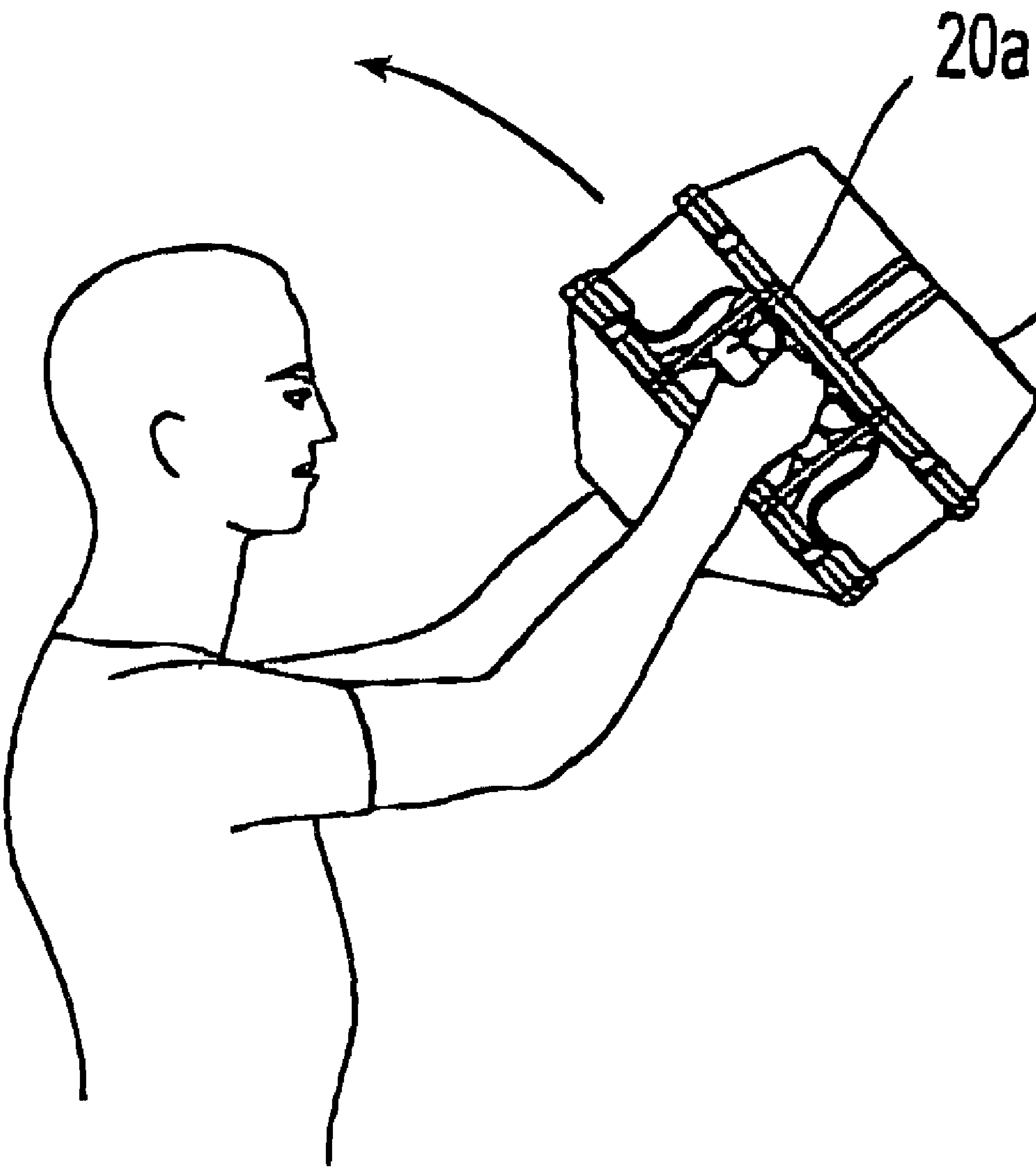

Fig. 33A

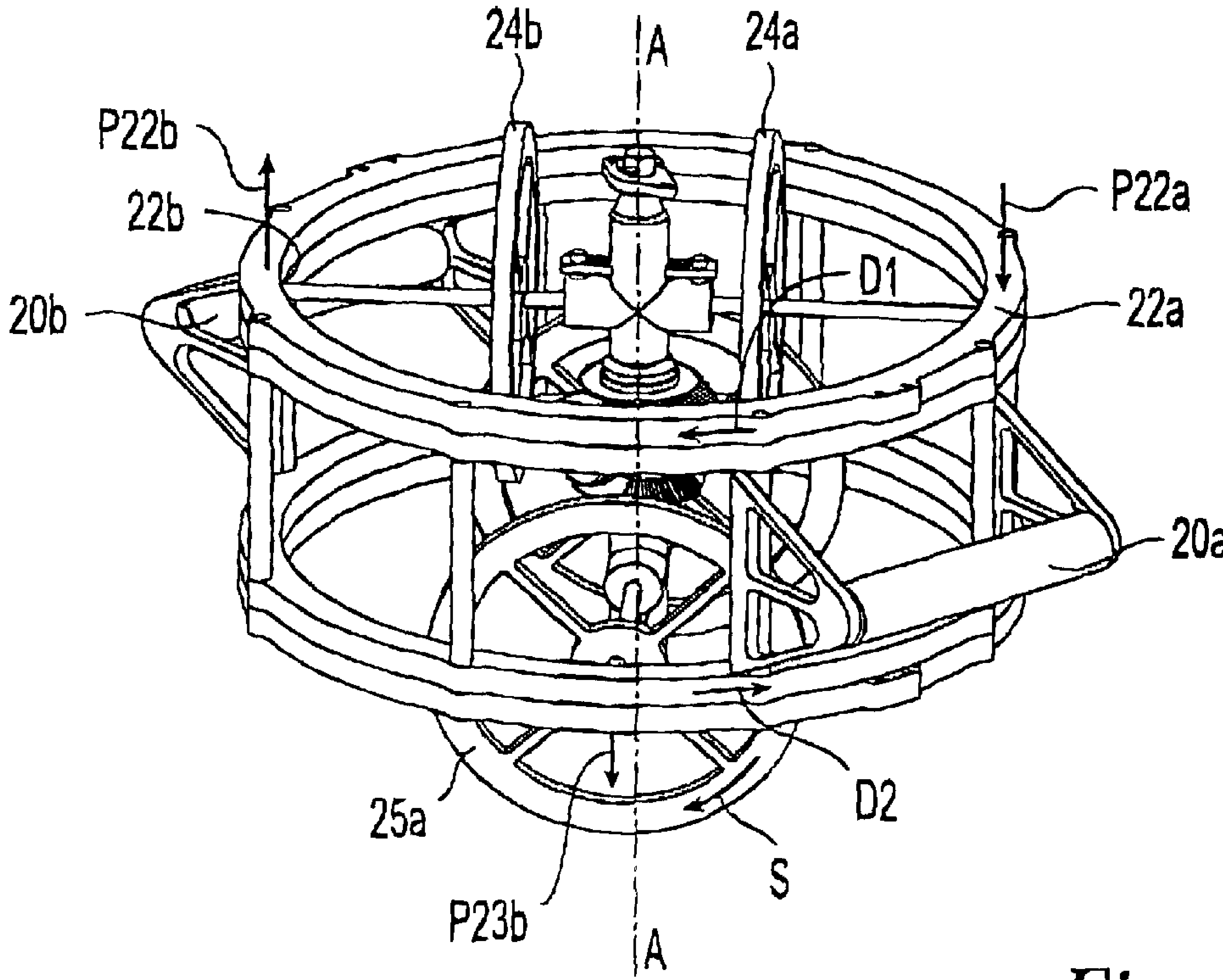

Fig. 33B

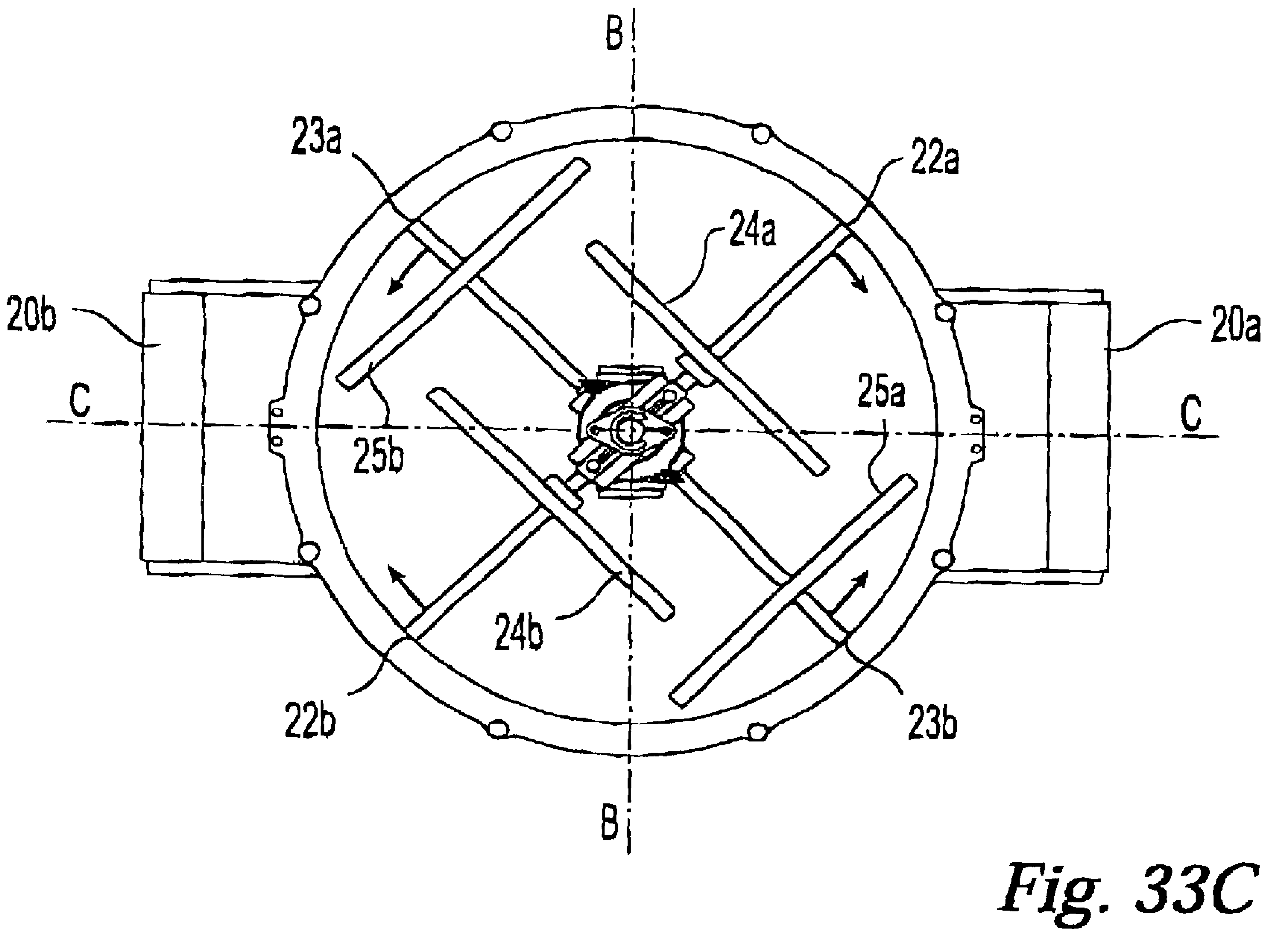

Fig. 33C

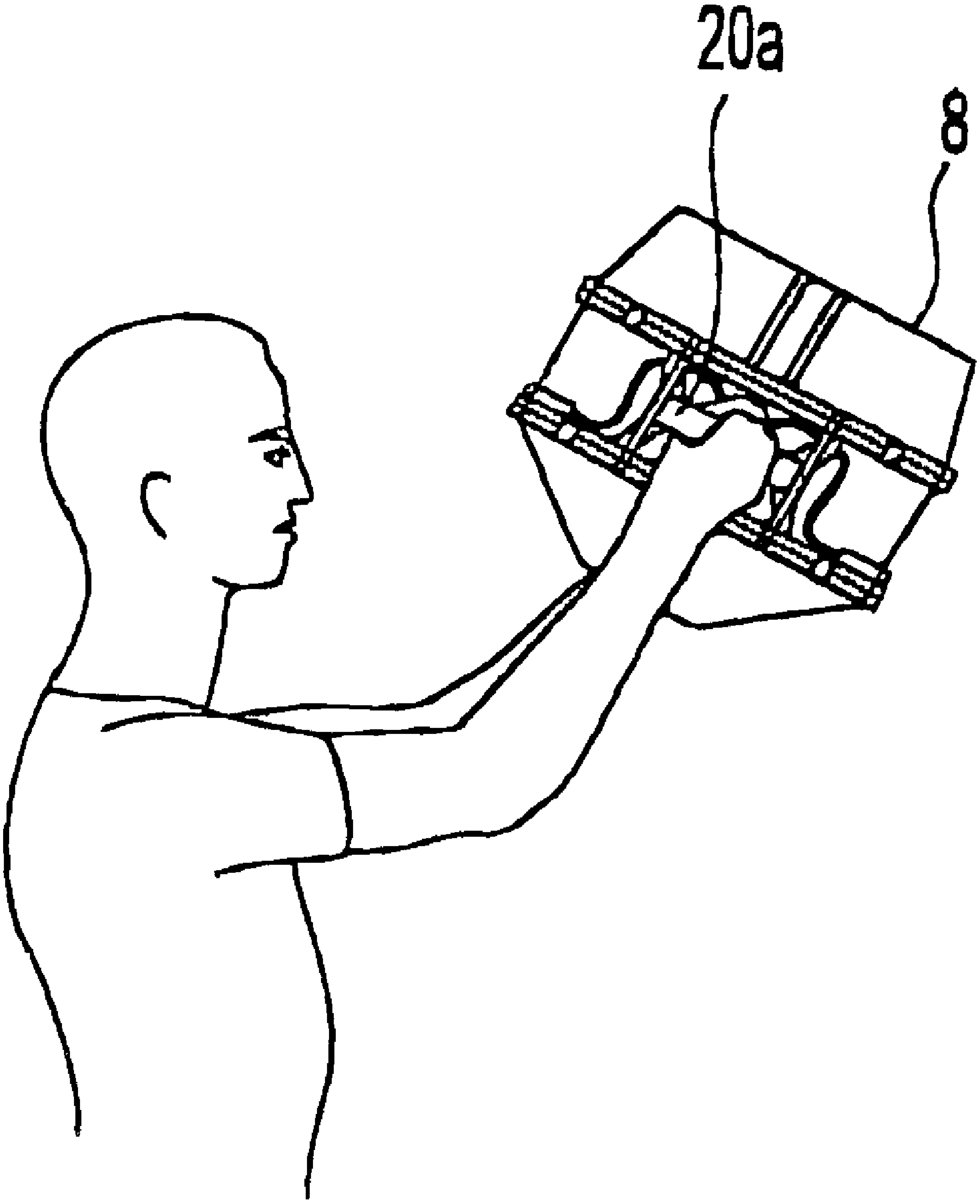

Fig. 34A

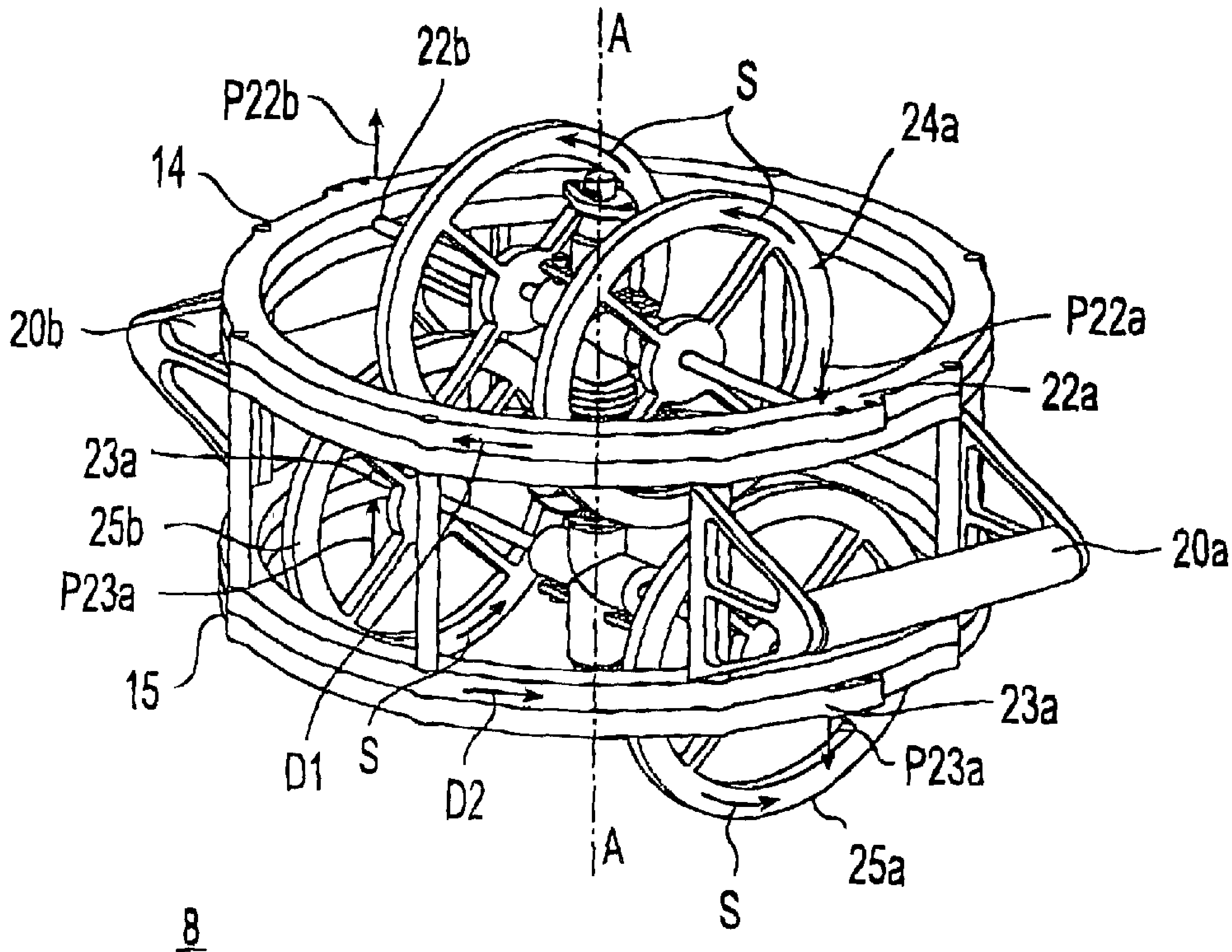

Fig. 34B

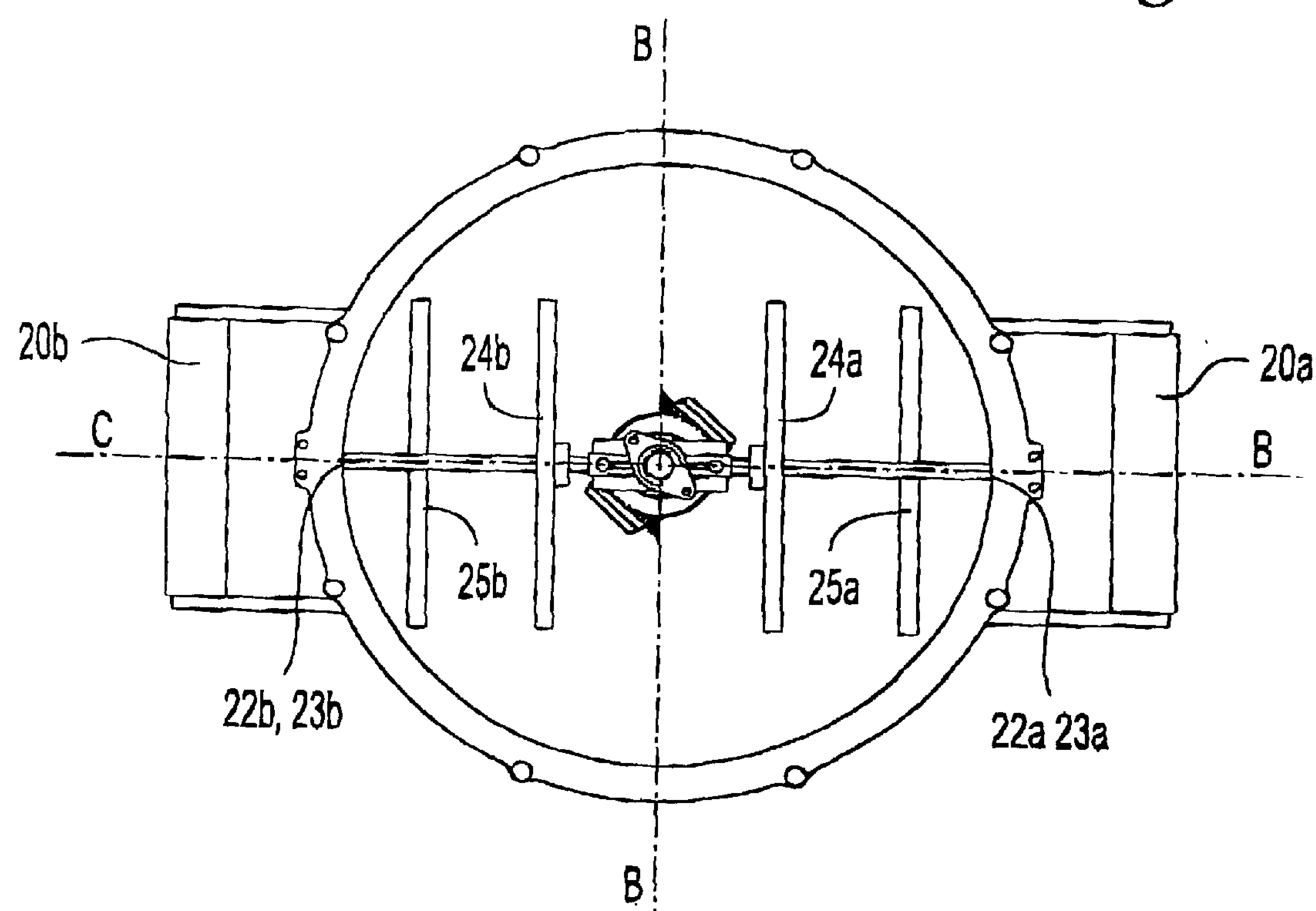

Fig. 34C

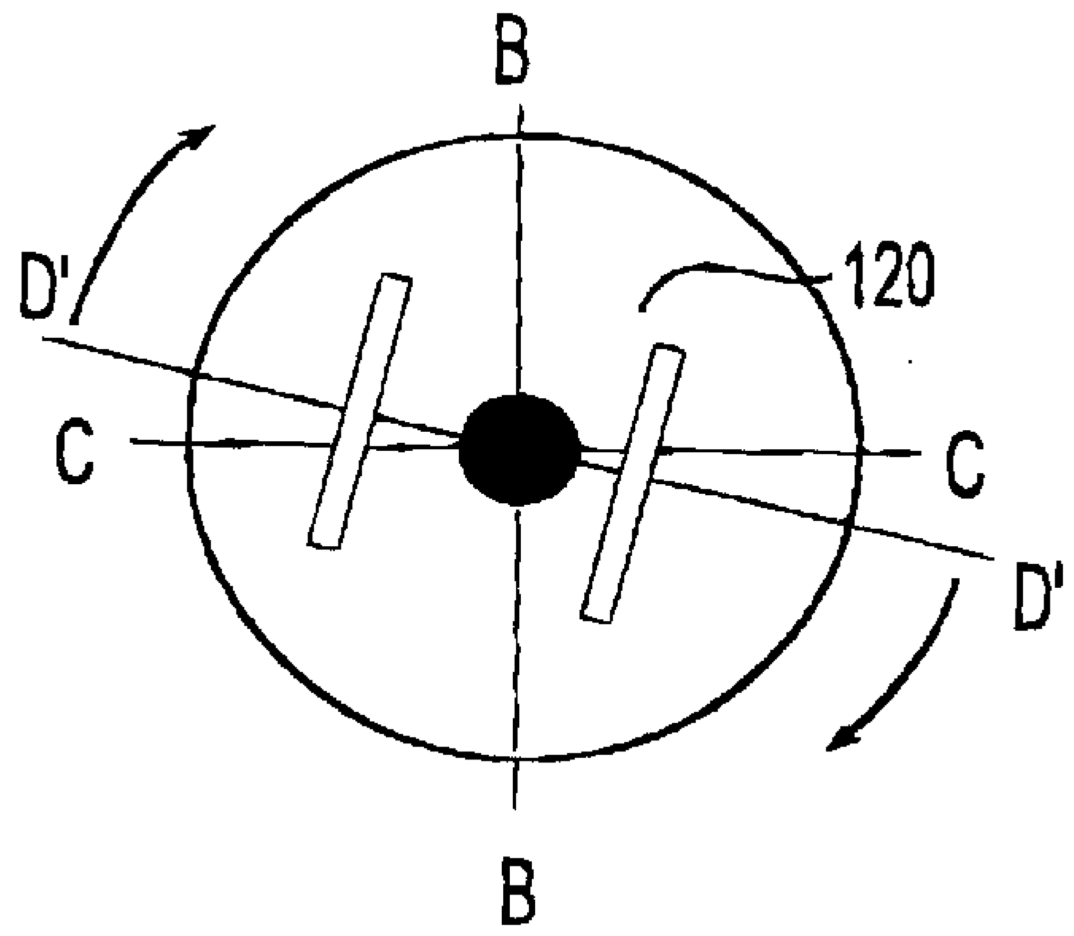

Fig. 35A

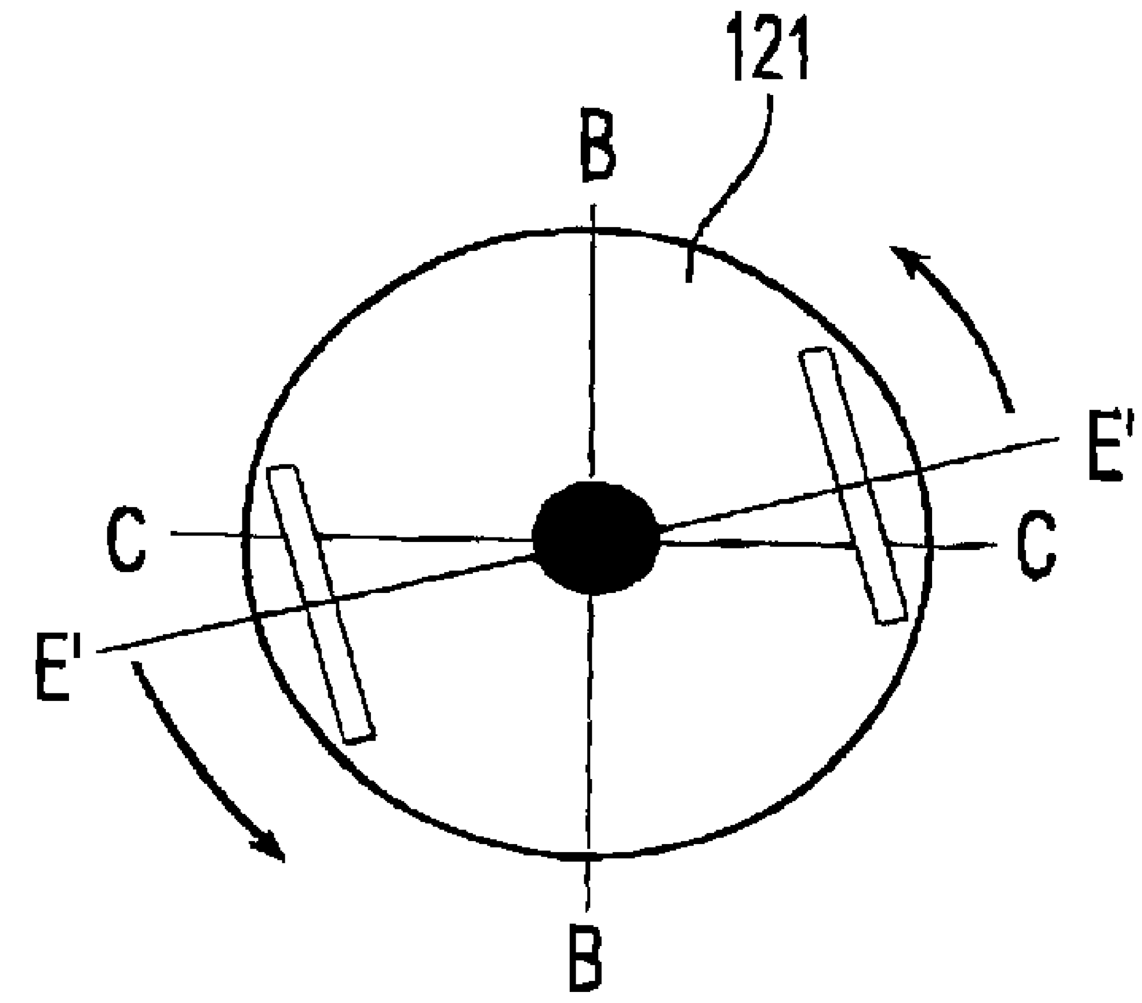

Fig. 35B

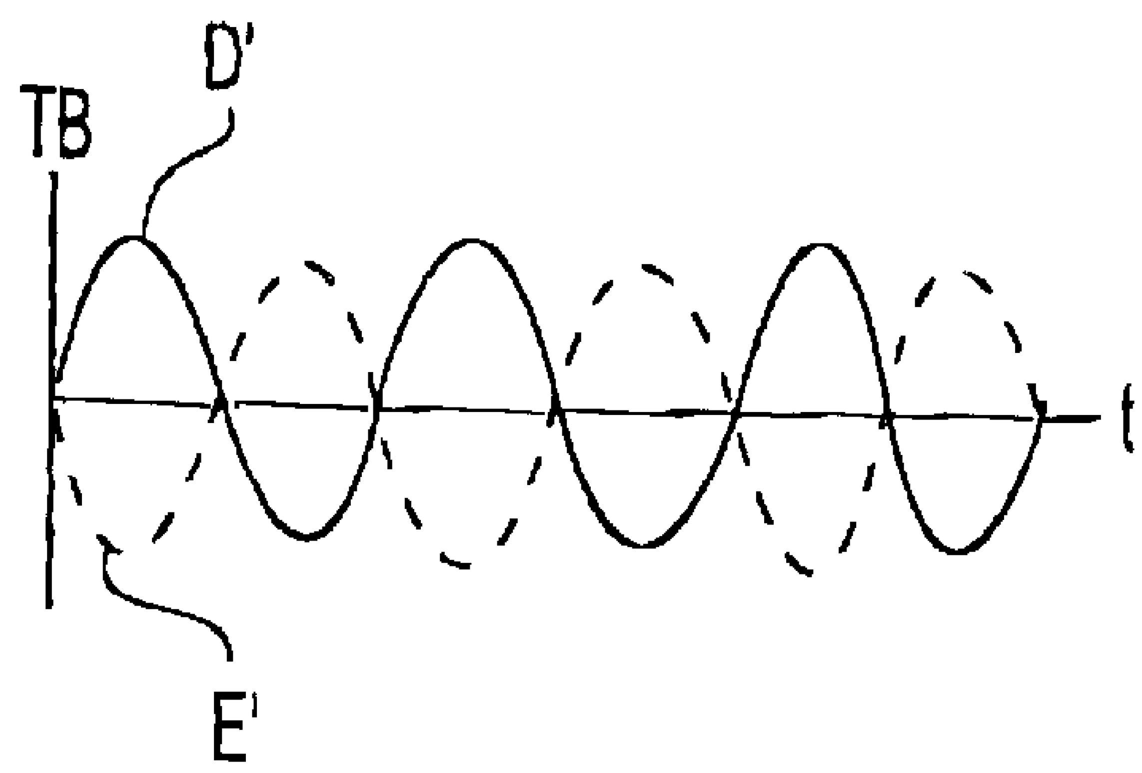

Fig. 35C

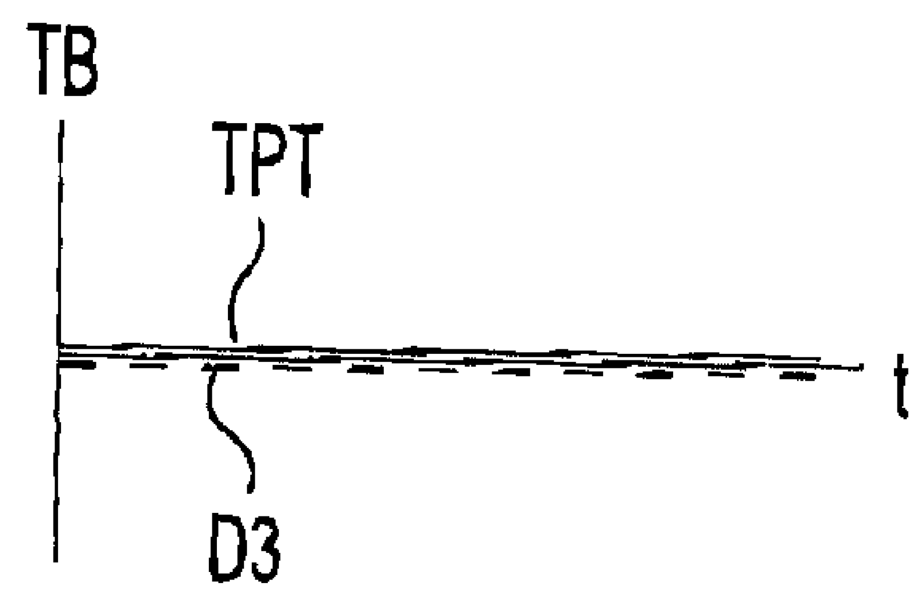

Fig. 35D

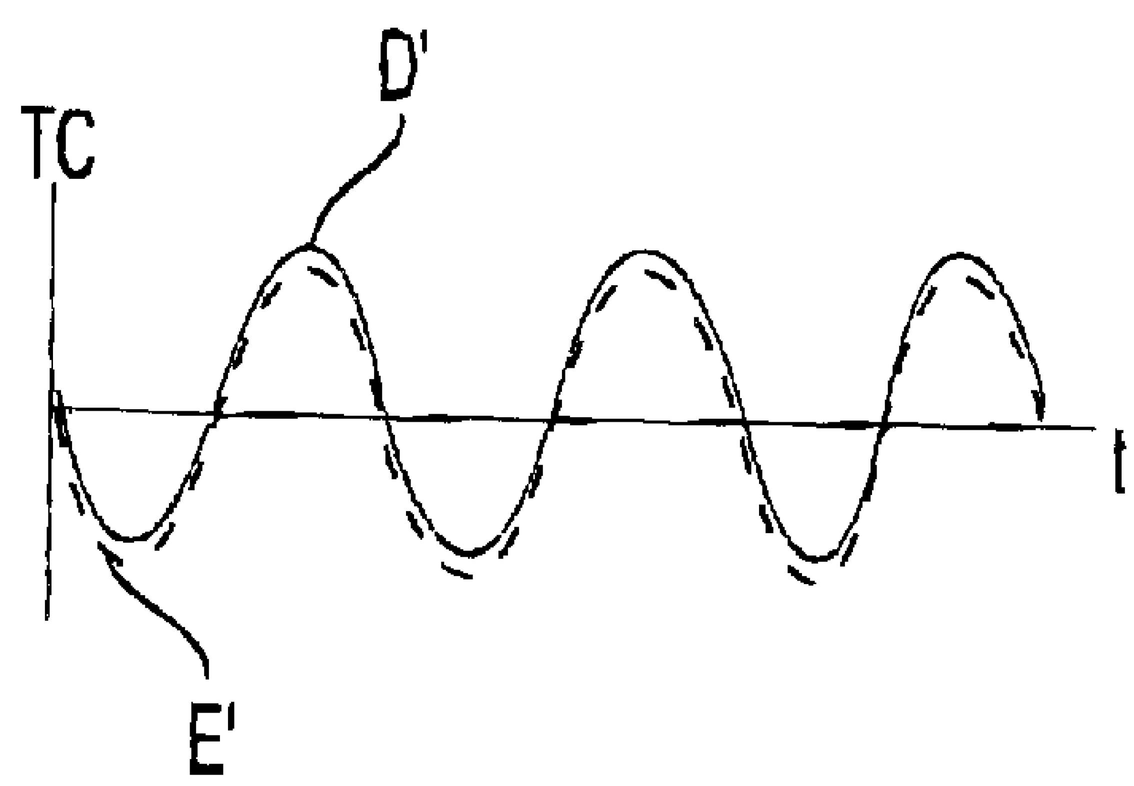

Fig. 35E

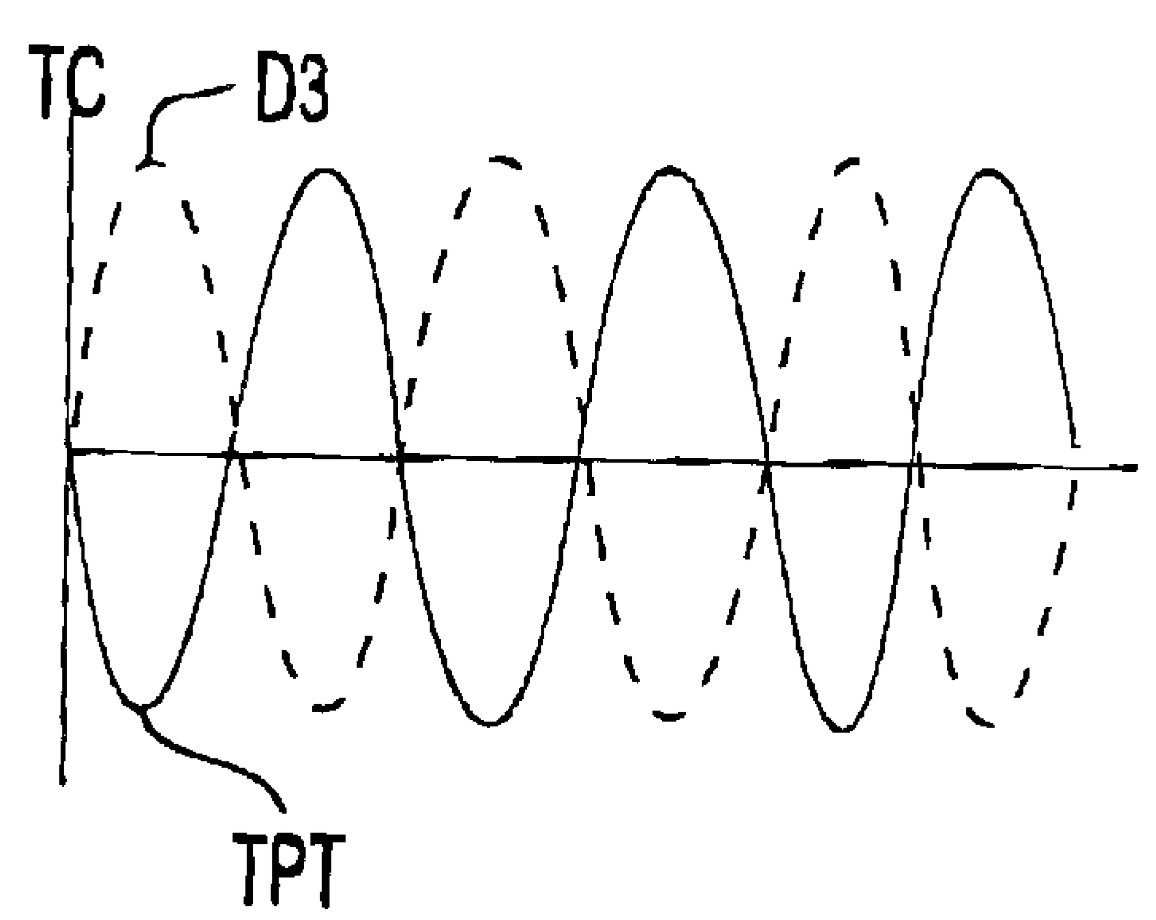

Fig. 35F

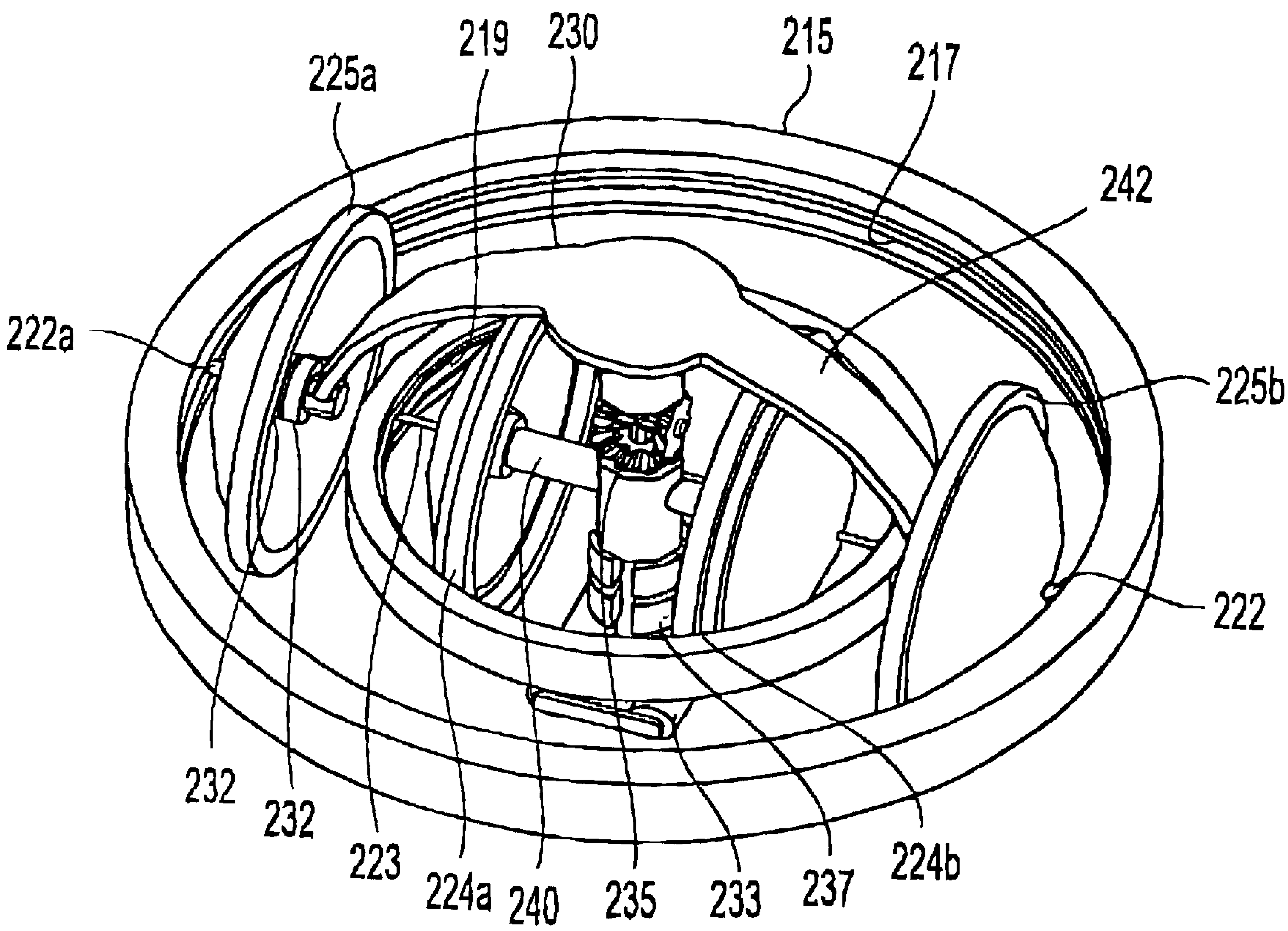
219
230
215
225a
217
242
222a
225b
222
232
232
223
224a
240
235
233
237
224b

Fig. 36

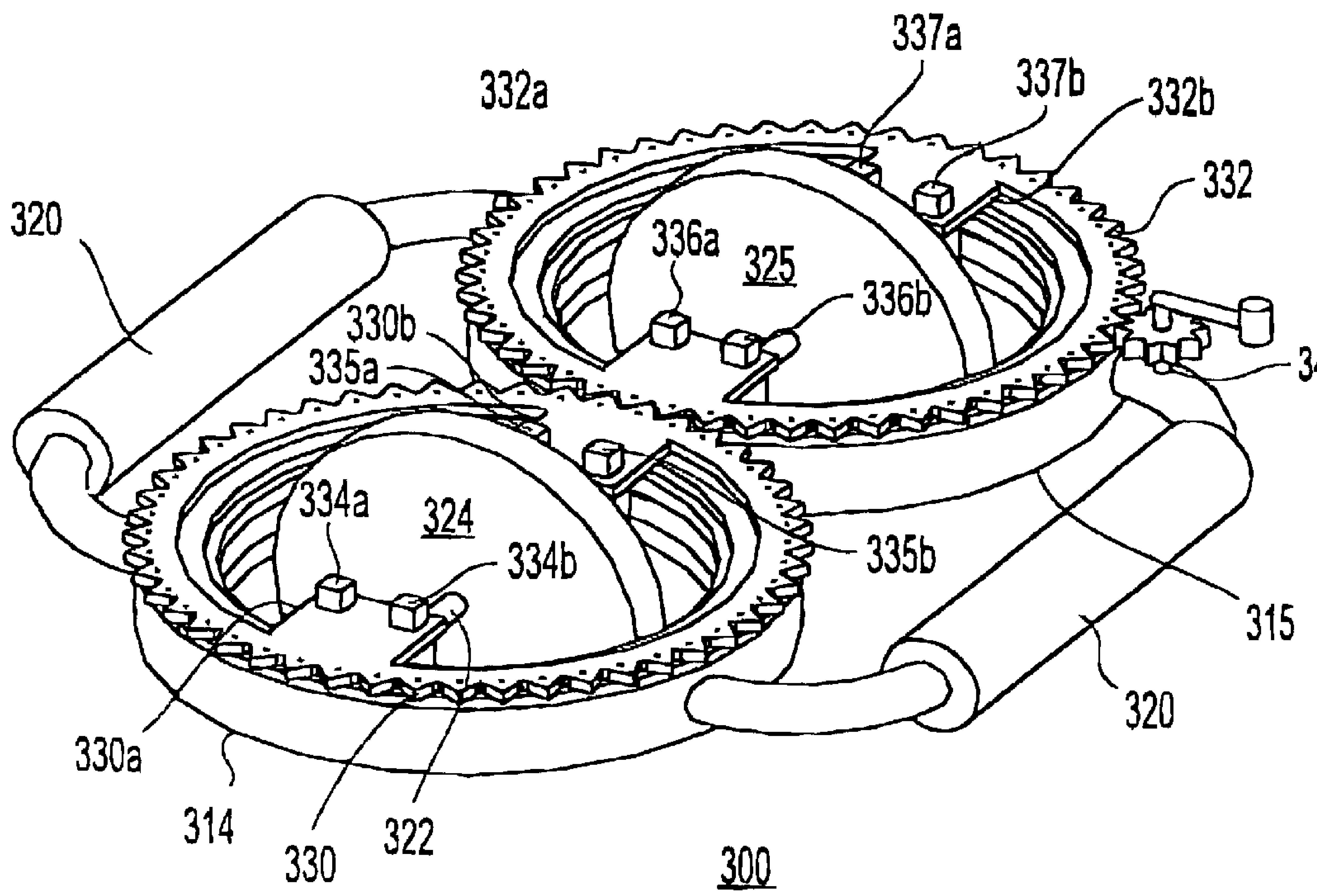

Fig. 37A

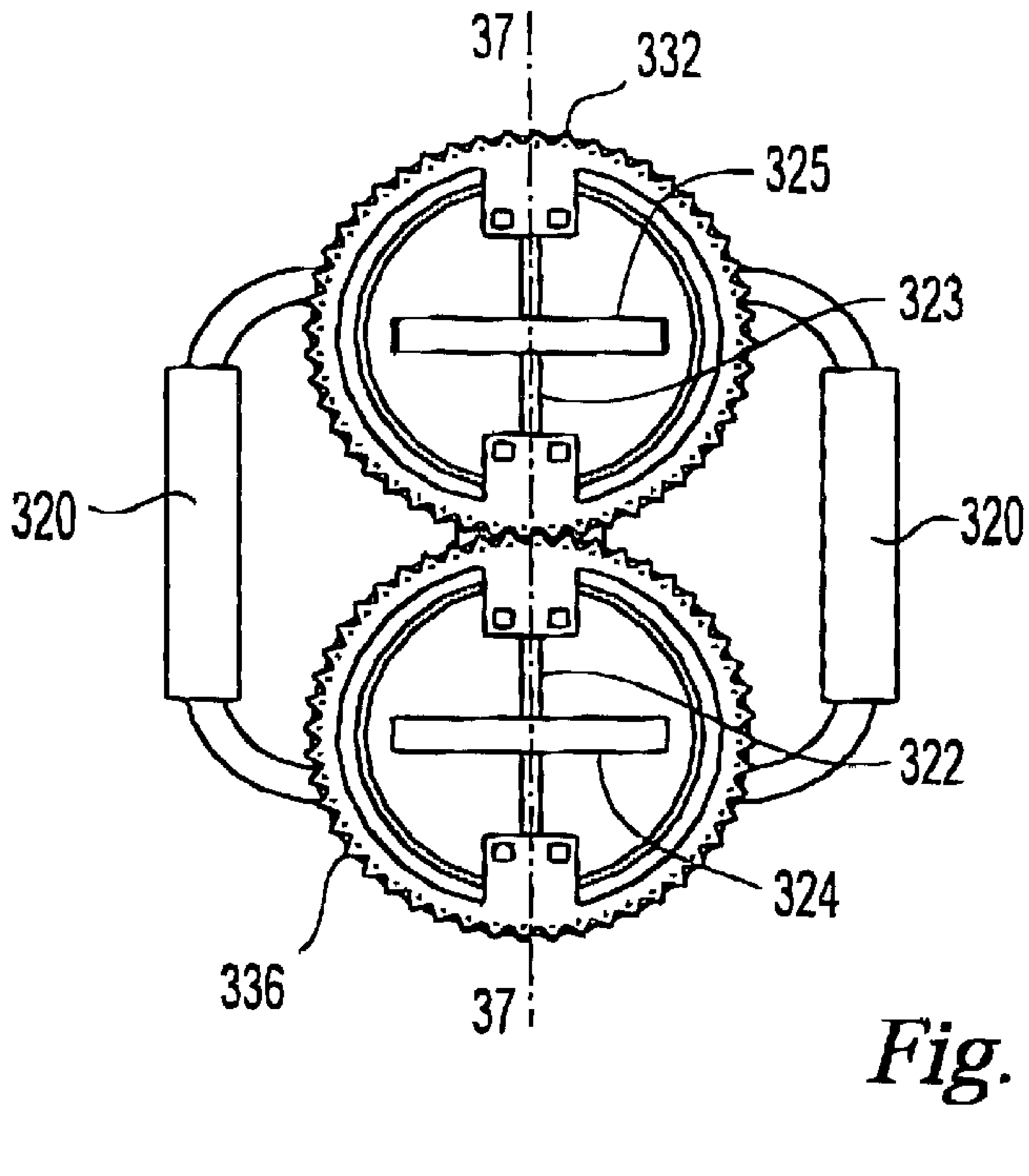

Fig. 37B

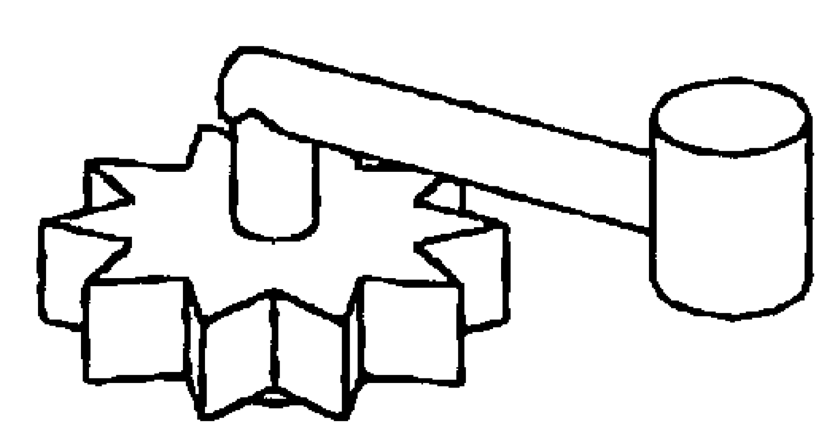

Fig. 37C

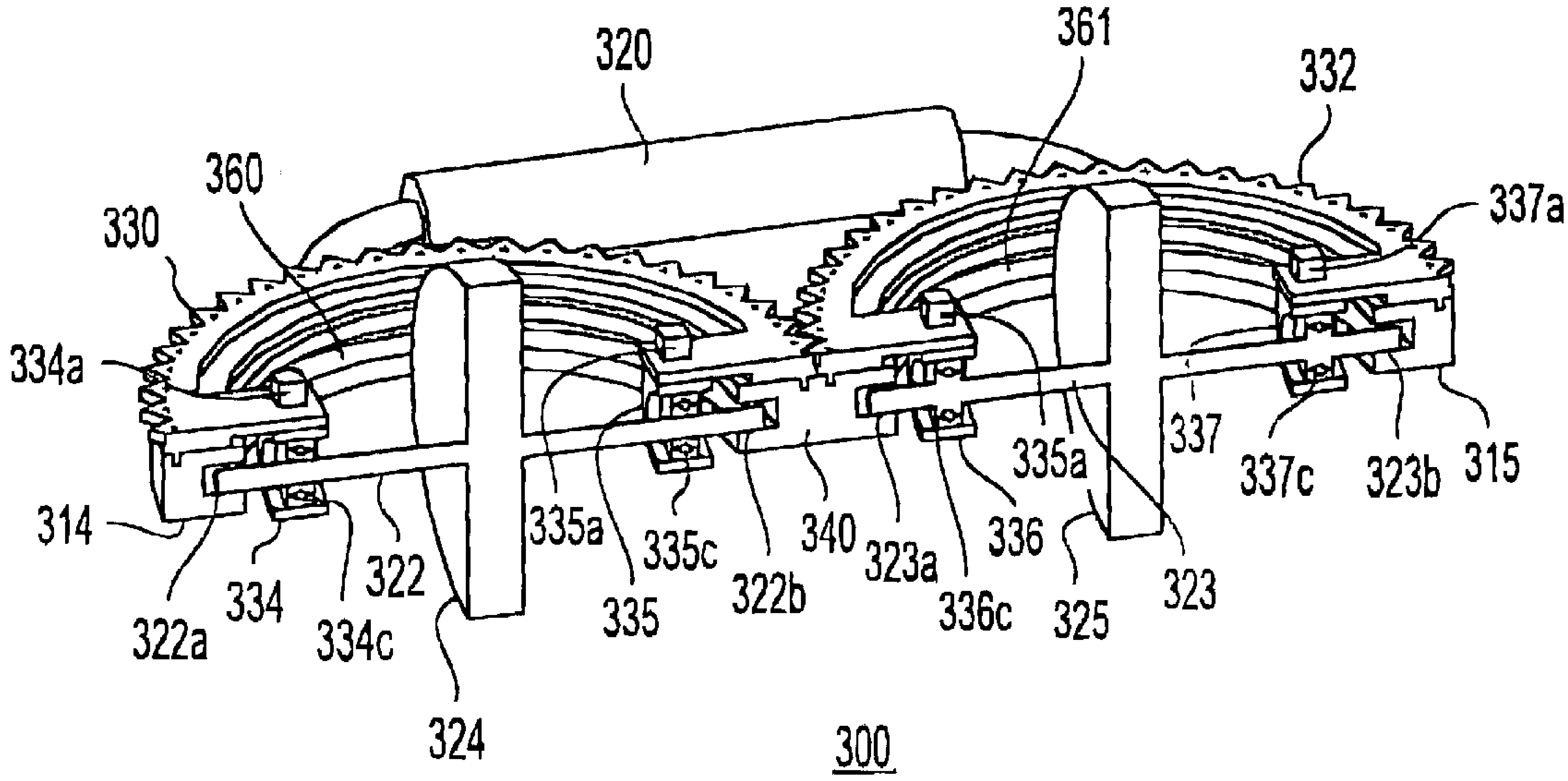

Fig. 37D

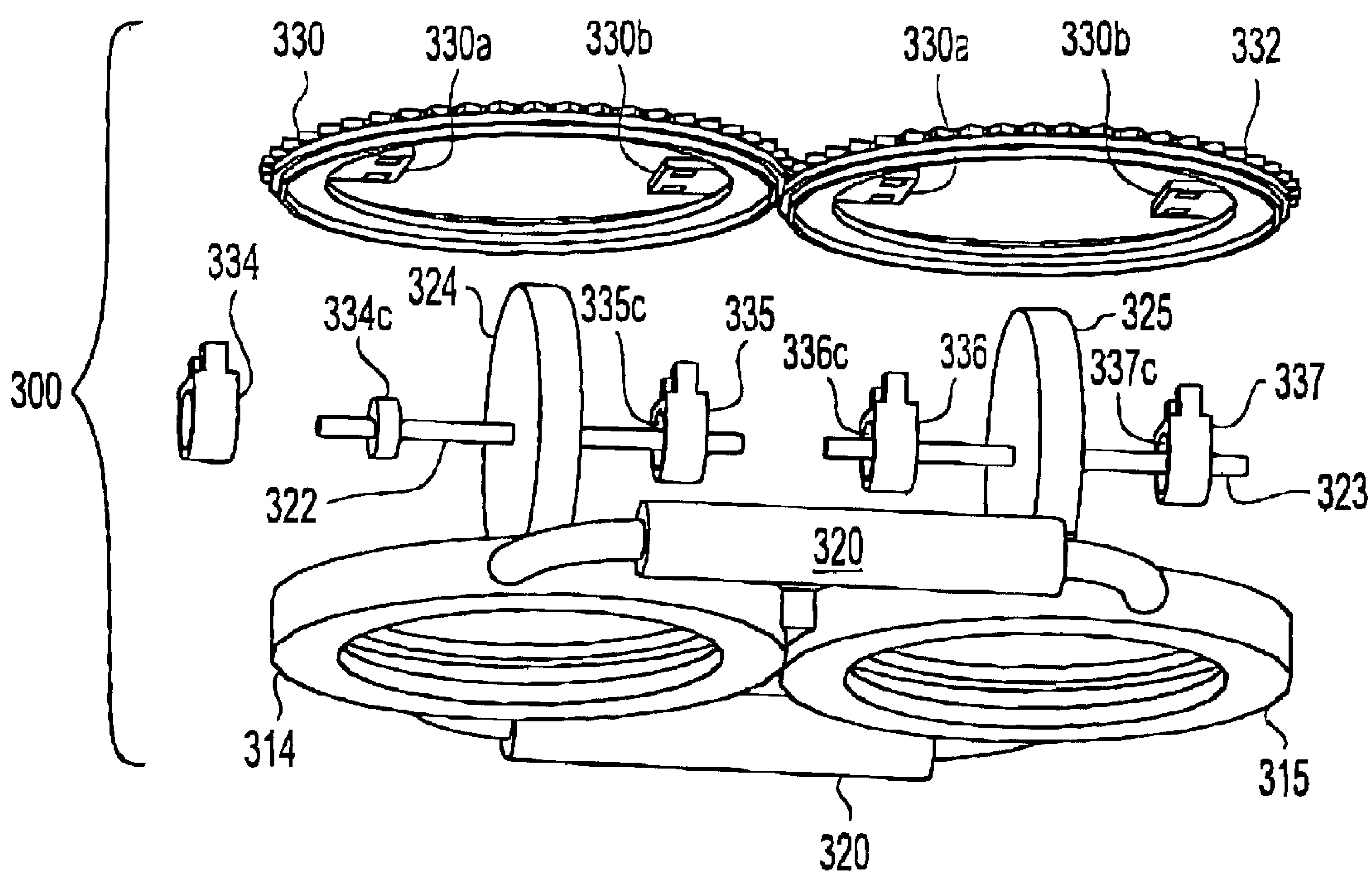

Fig. 37E

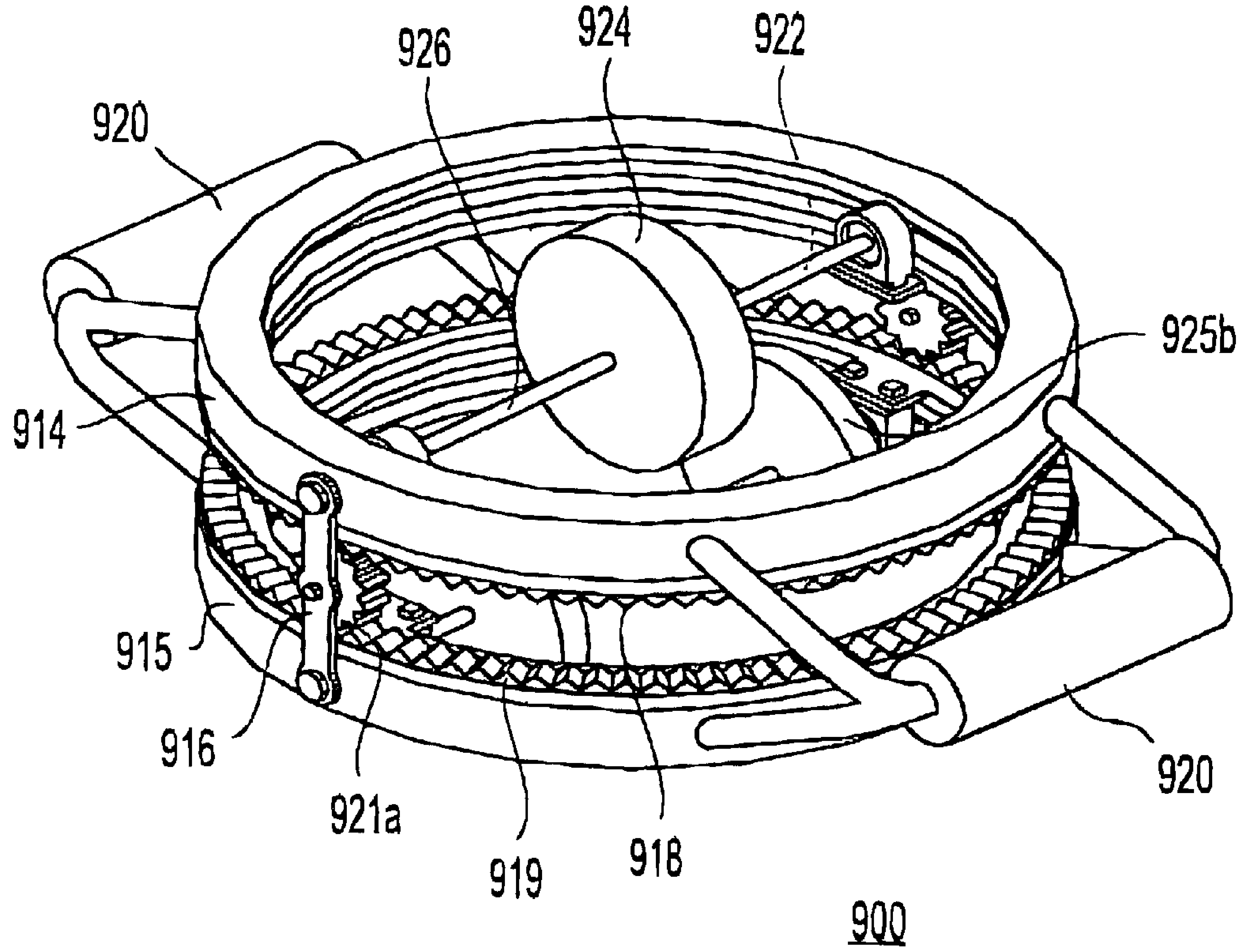

Fig. 38A

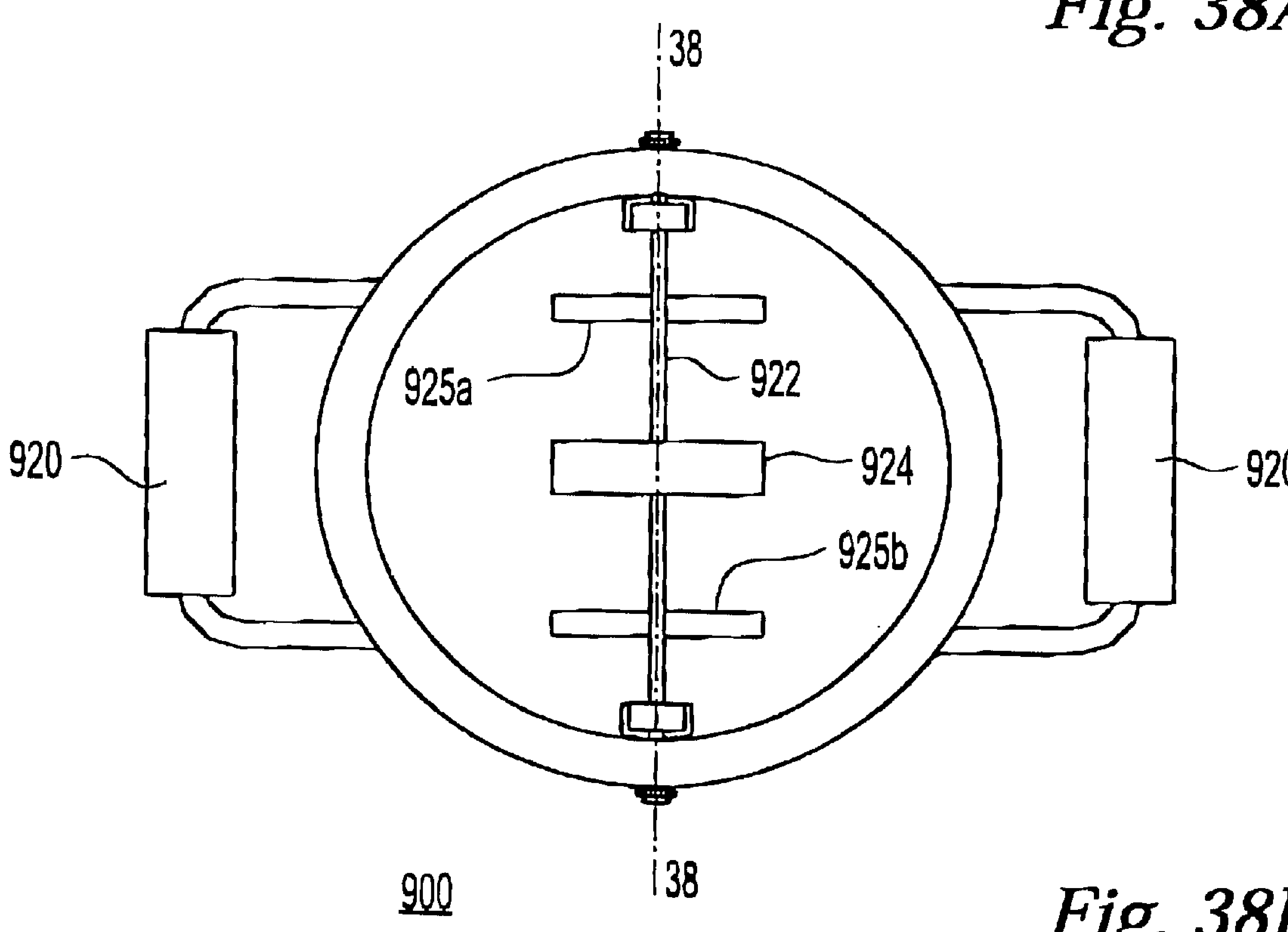

Fig. 38B

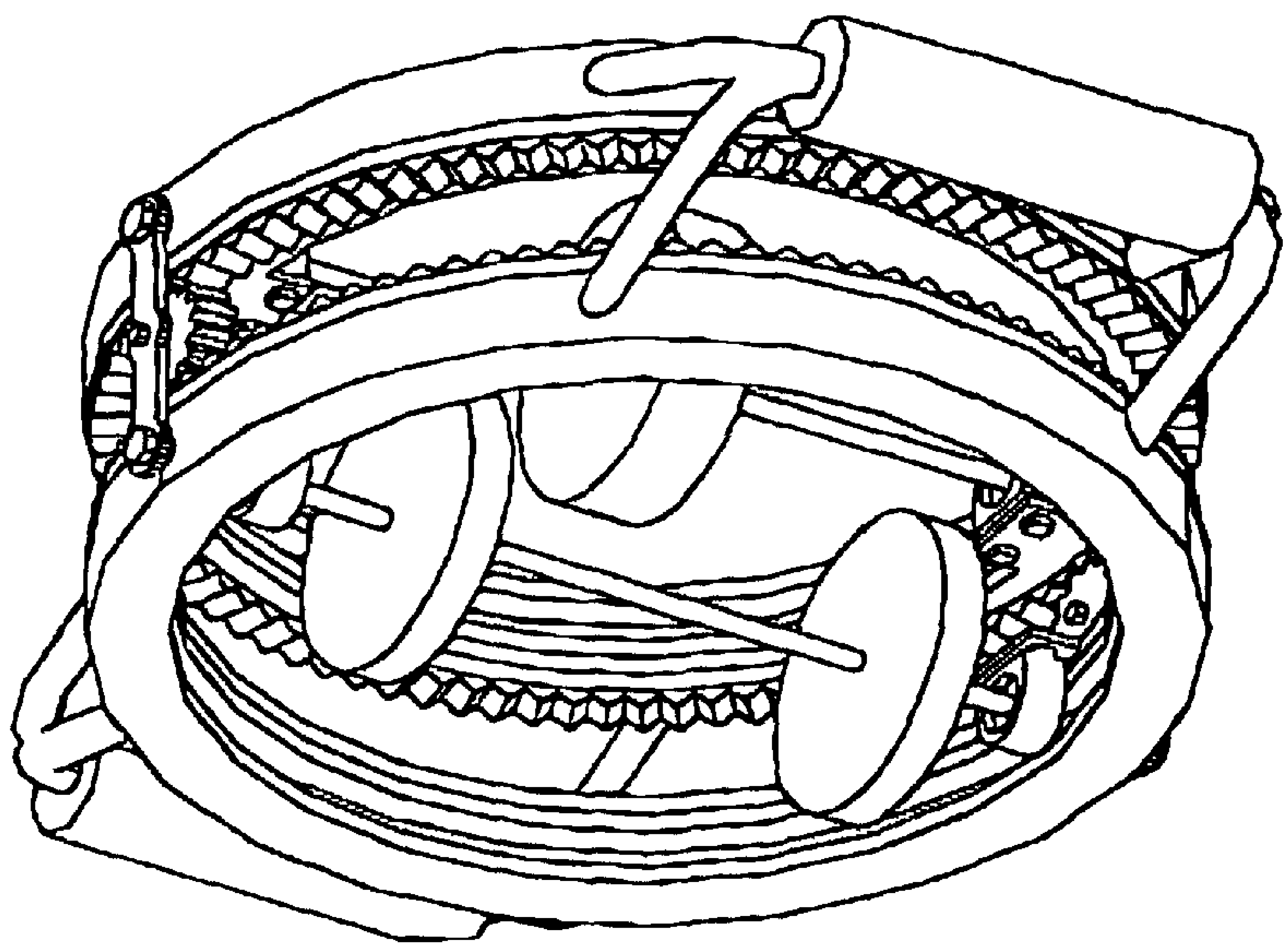

Fig. 38C

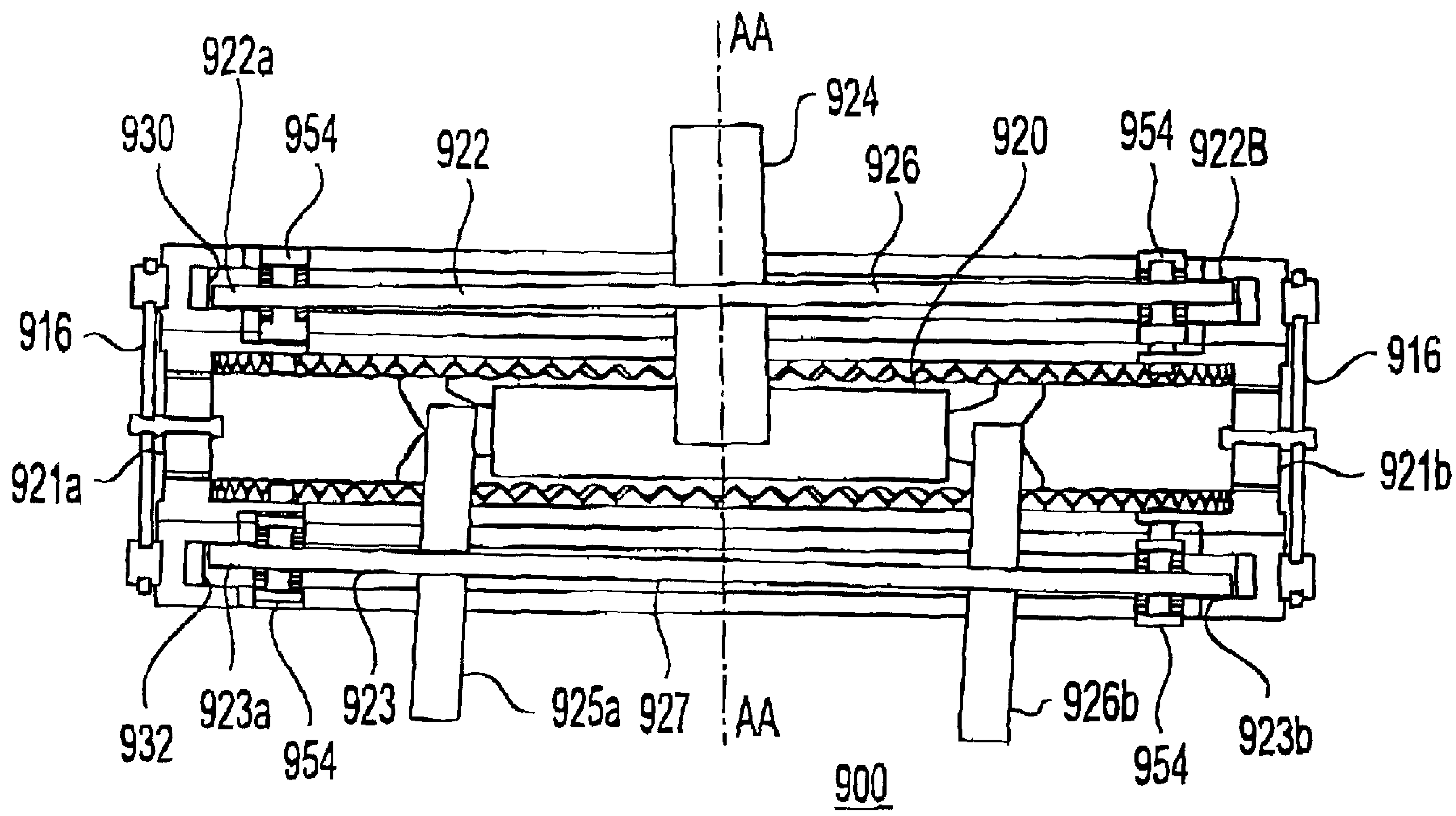

Fig. 38D

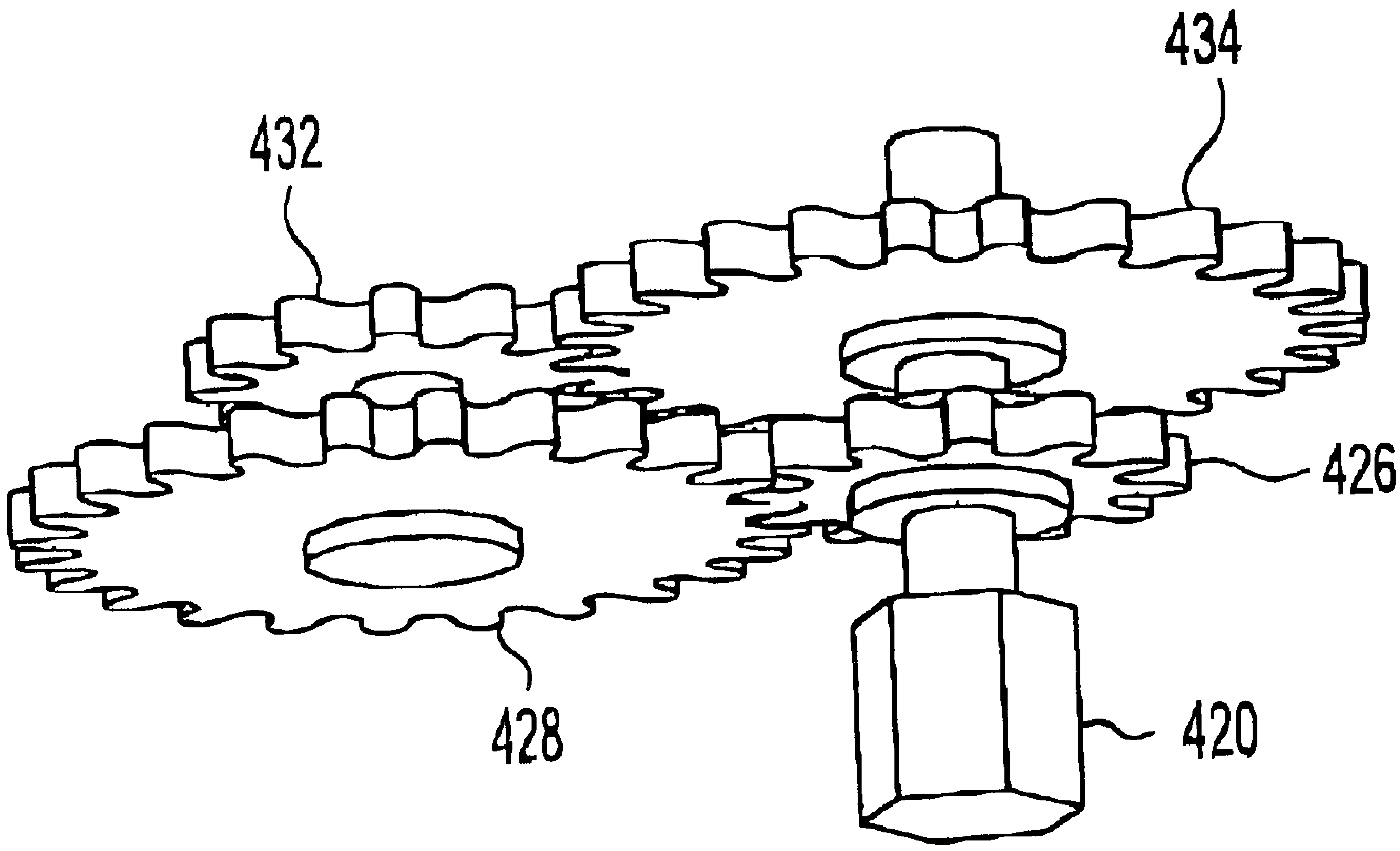

Fig. 39

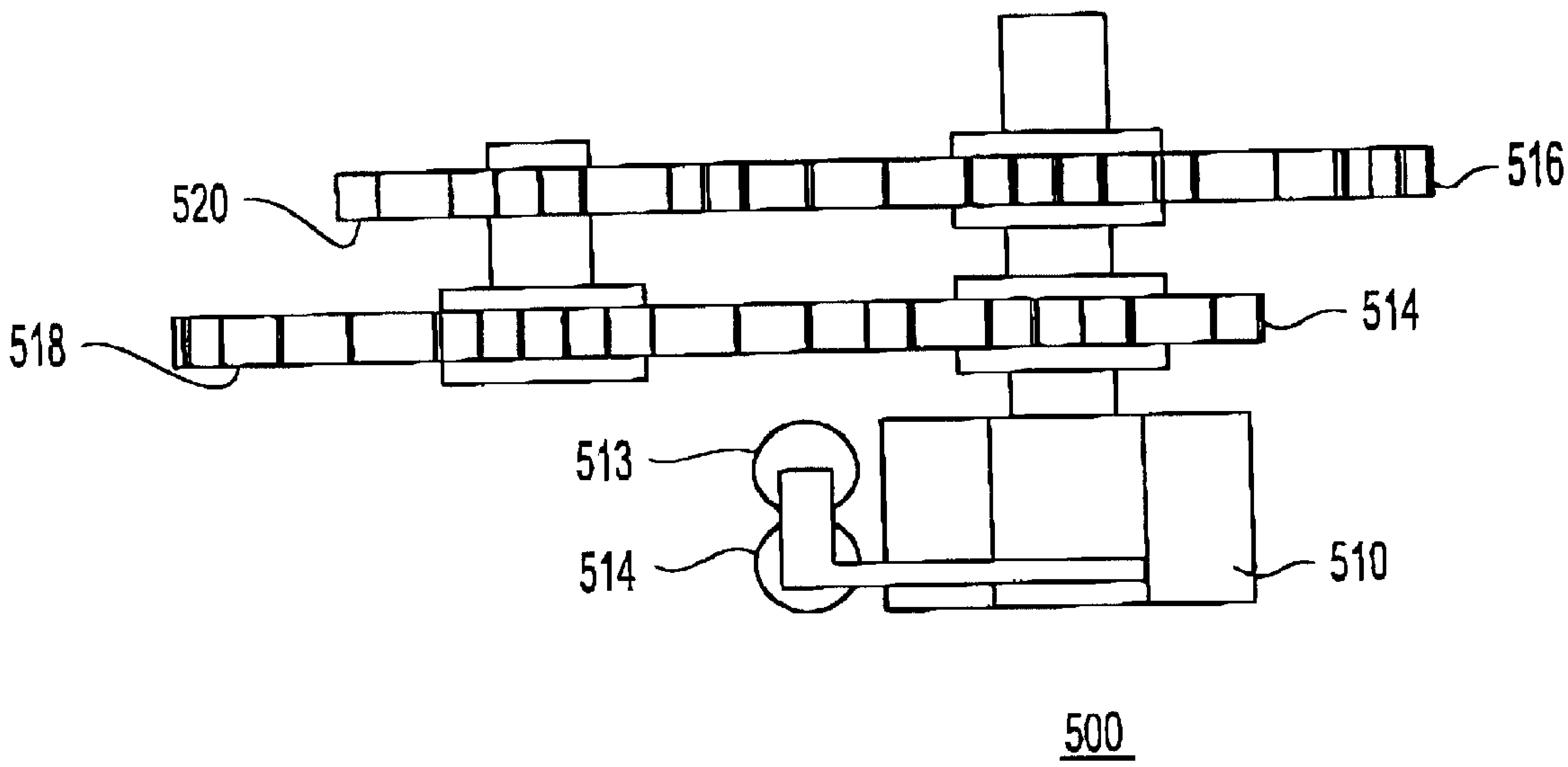

Fig. 40A

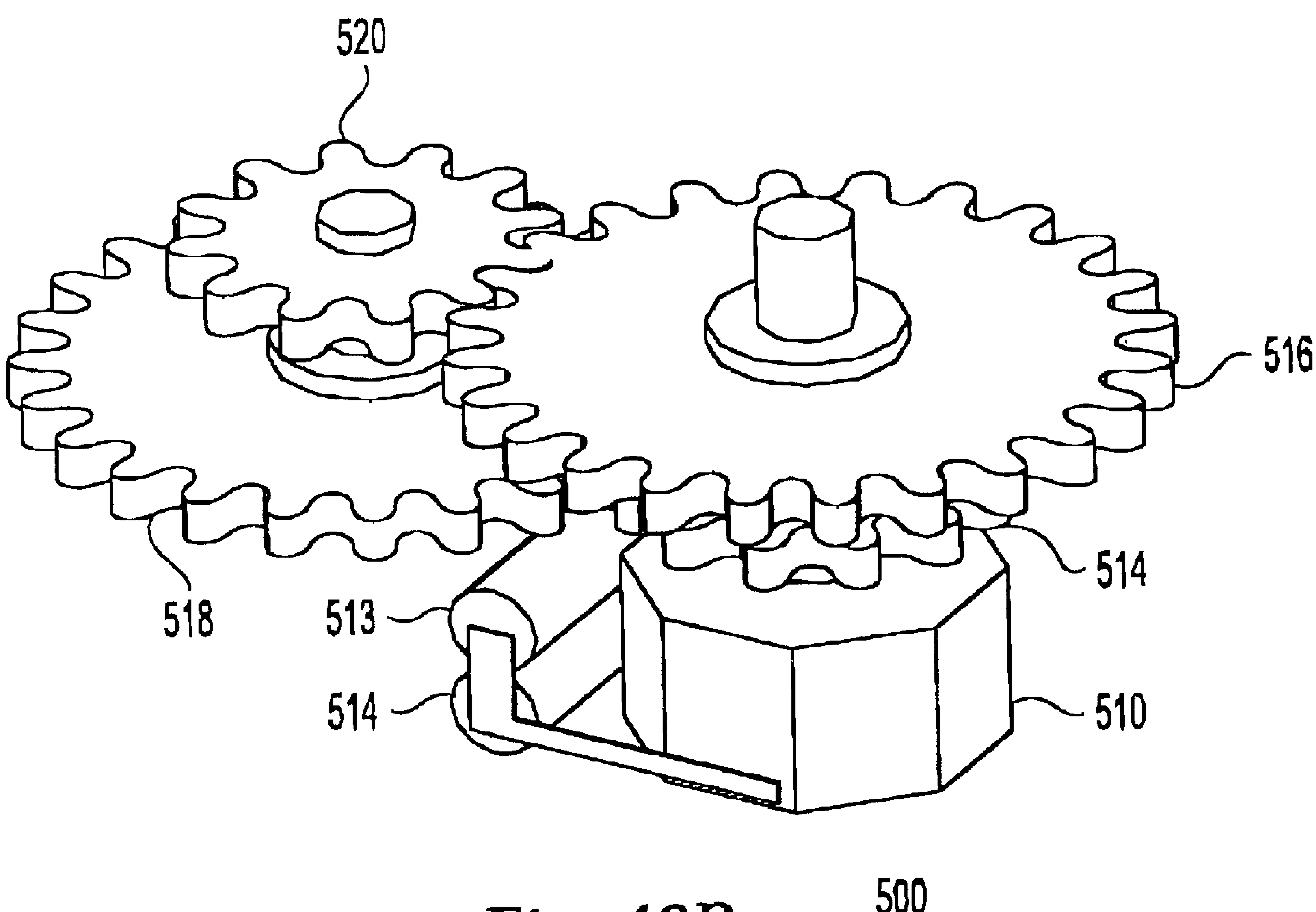

Fig. 40B

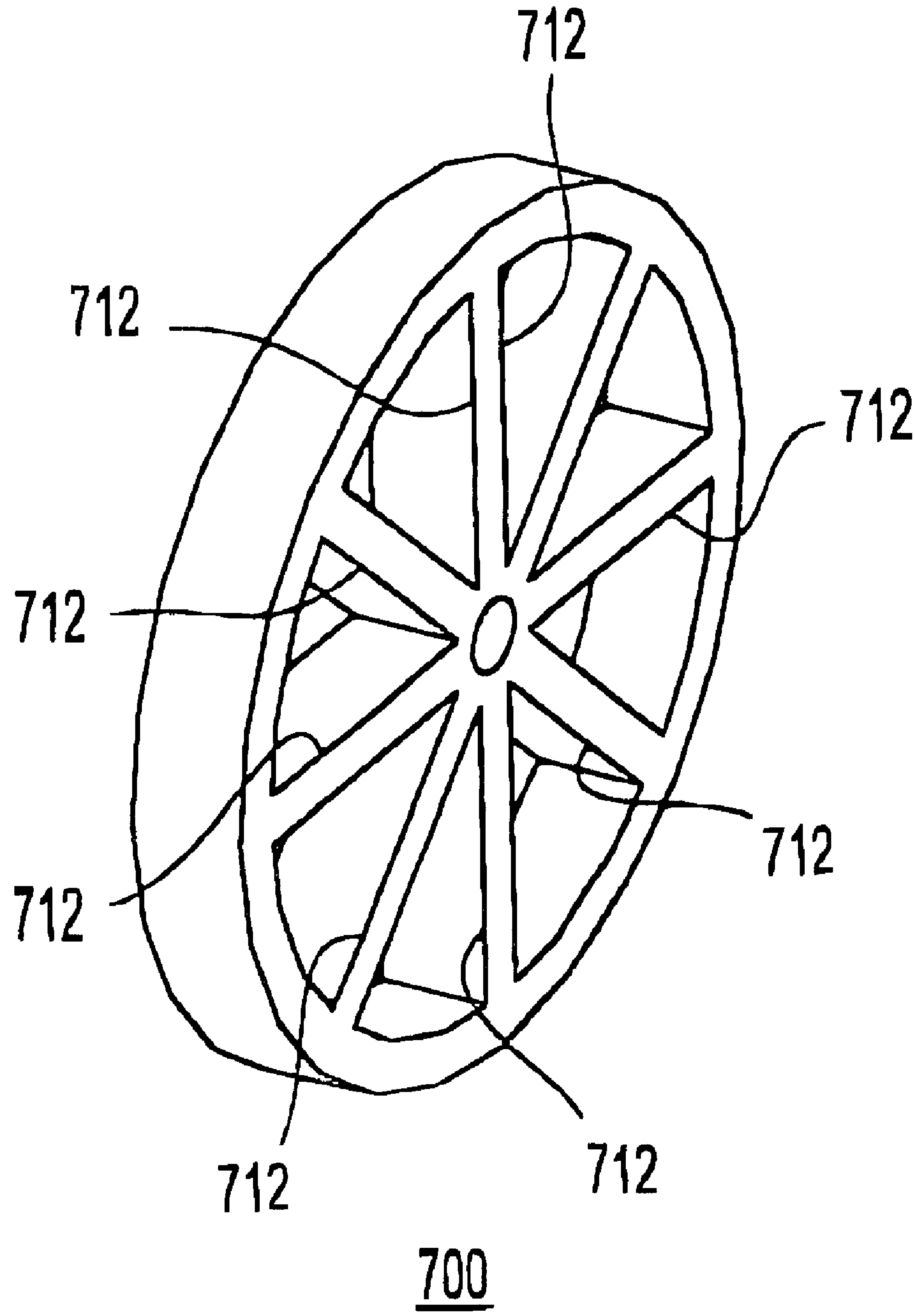

Fig. 41

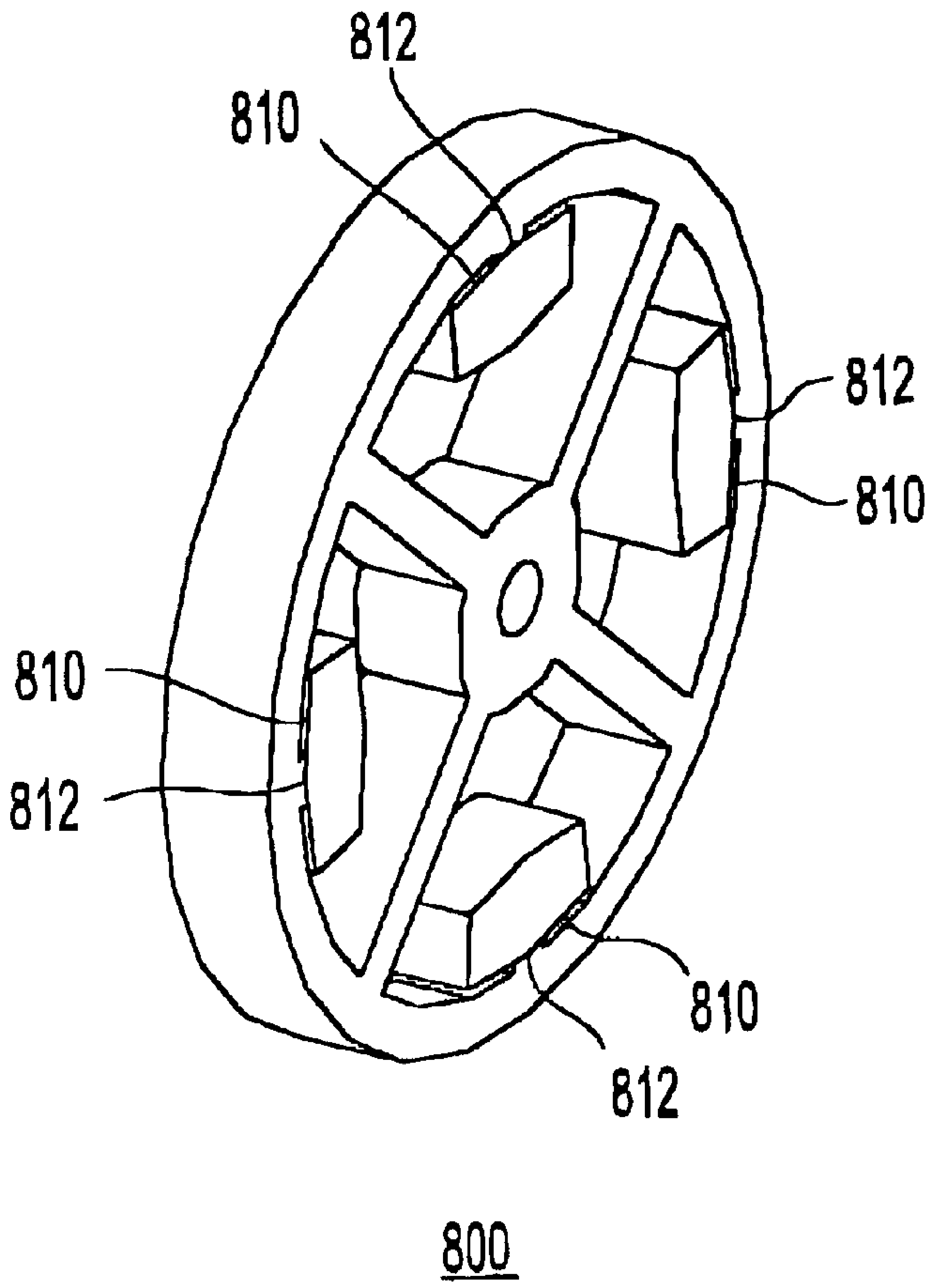

Fig. 42A

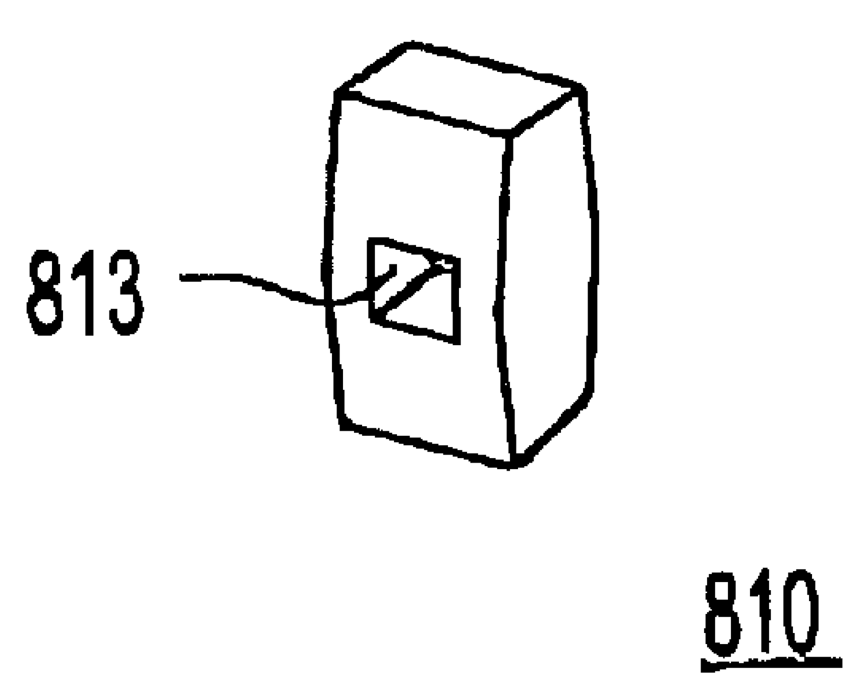

Fig. 42B

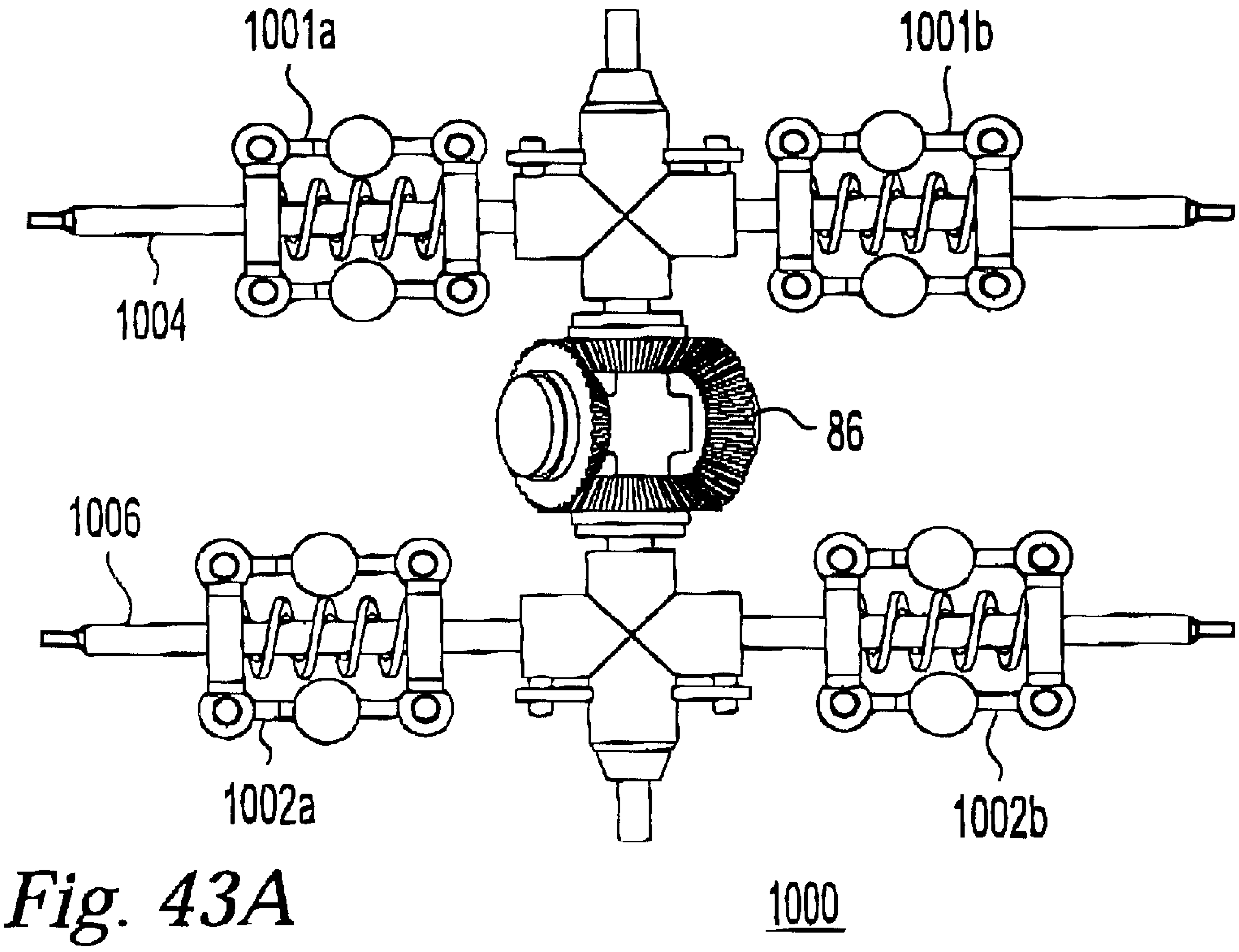

Fig. 43A

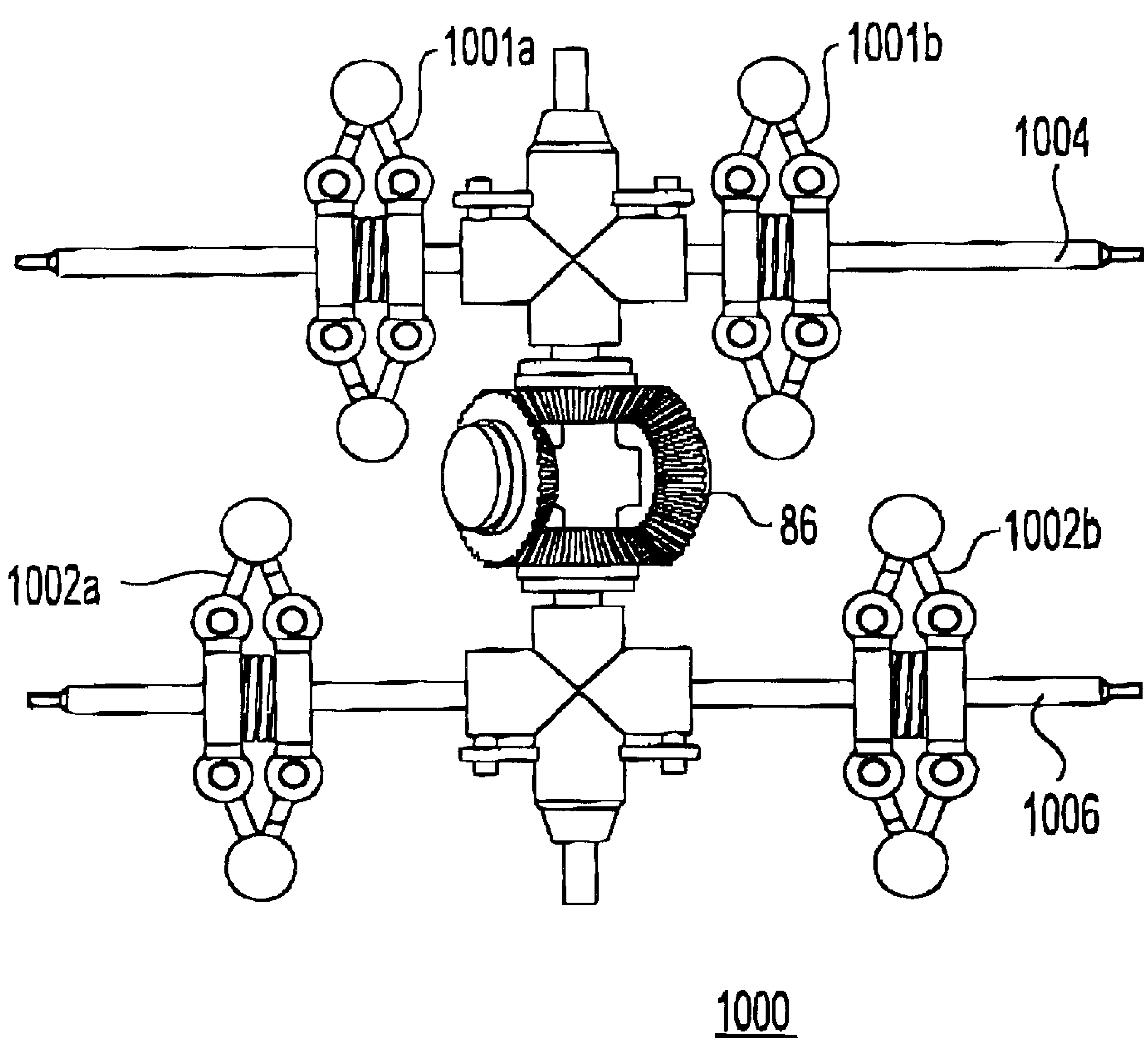

Fig. 43B

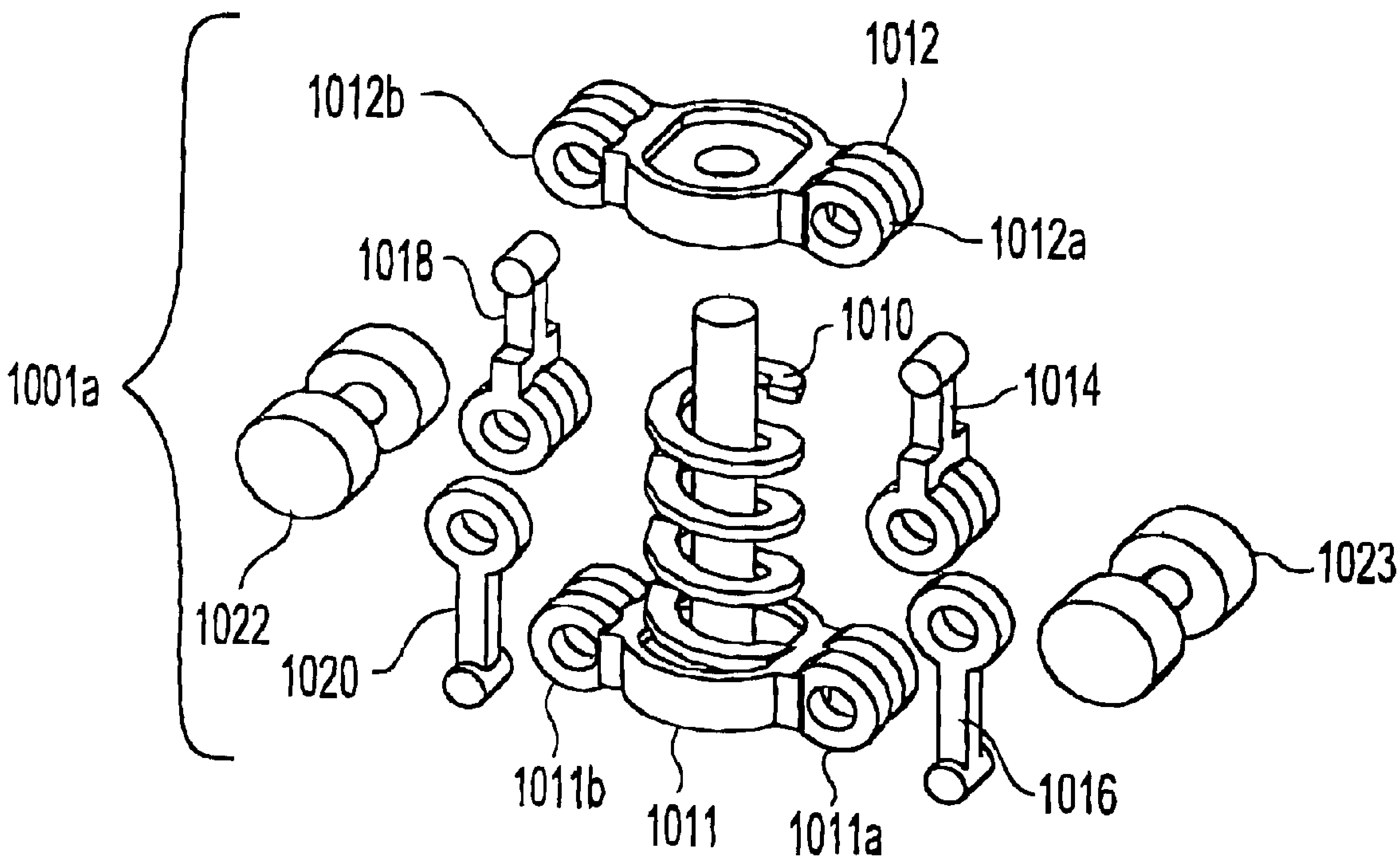
1001a
1012
1012b
1012a
1018
1010
1014
1022
1023
1020
1011b
1011
1011a
1016

Fig. 43C

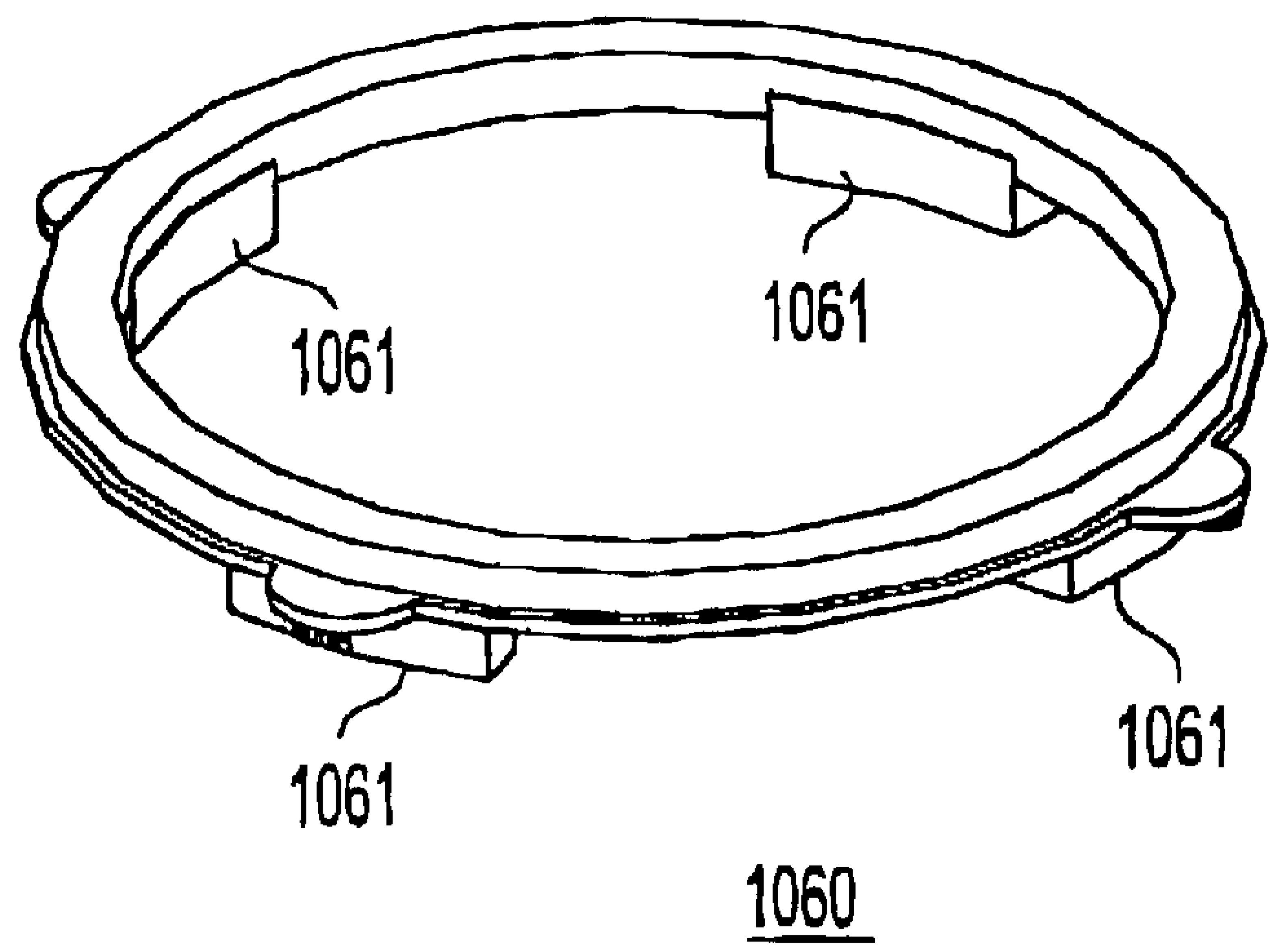

Fig. 44A

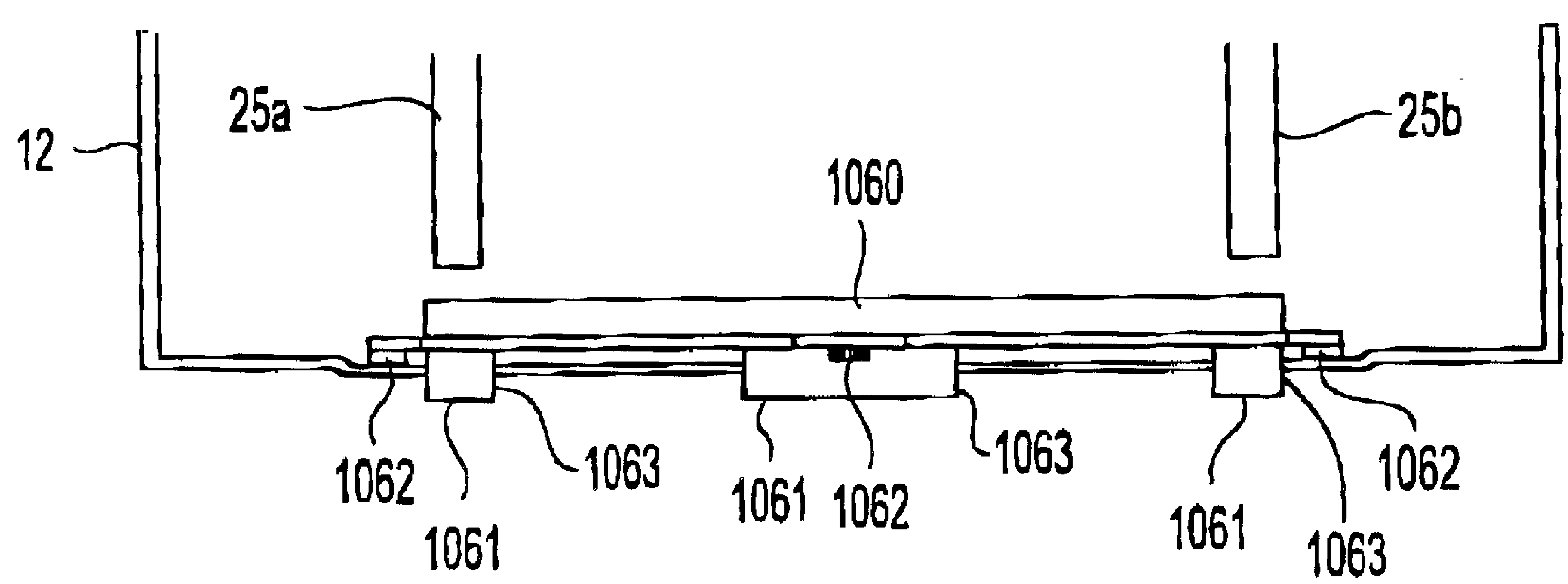

Fig. 44B

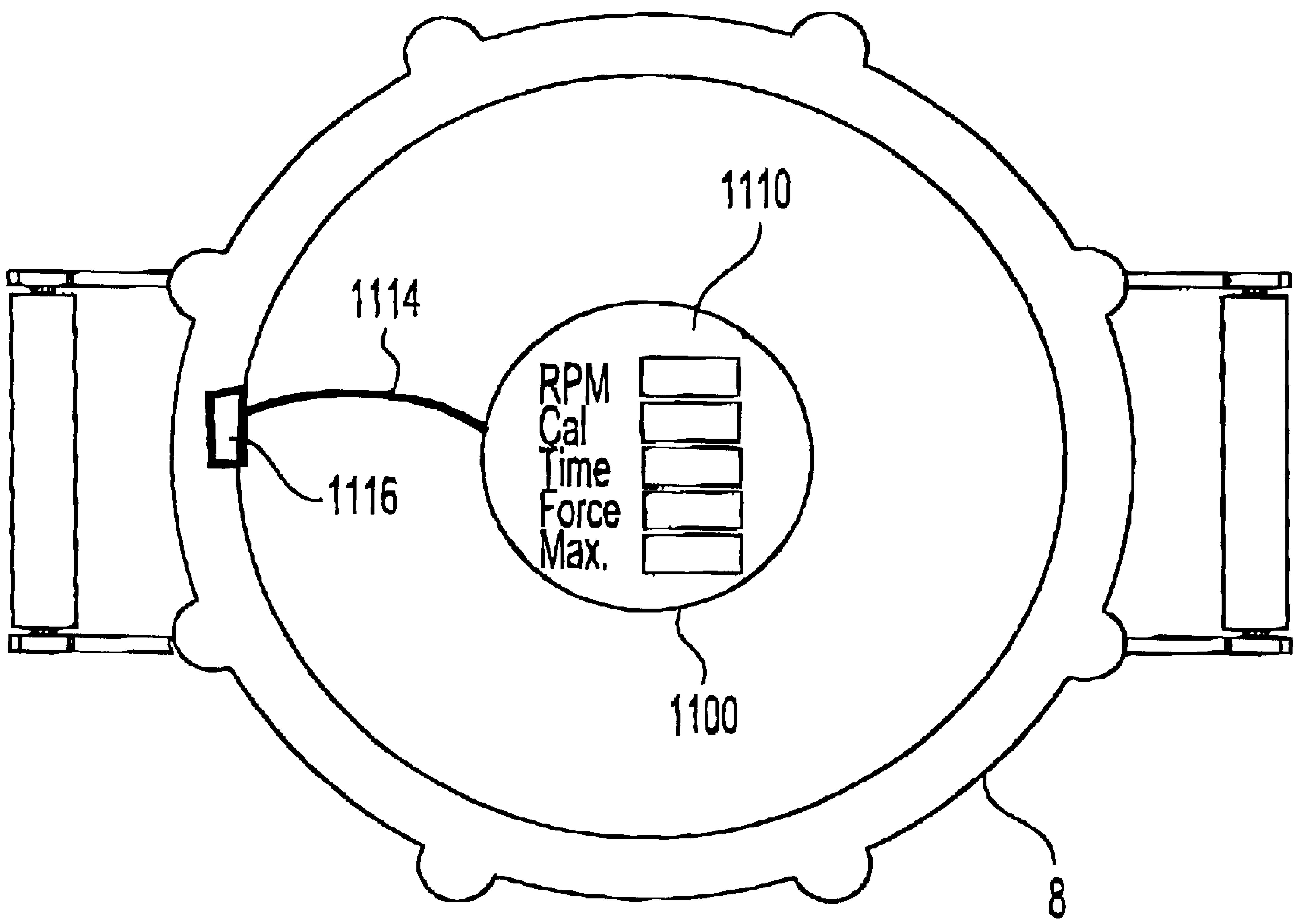

Fig. 45

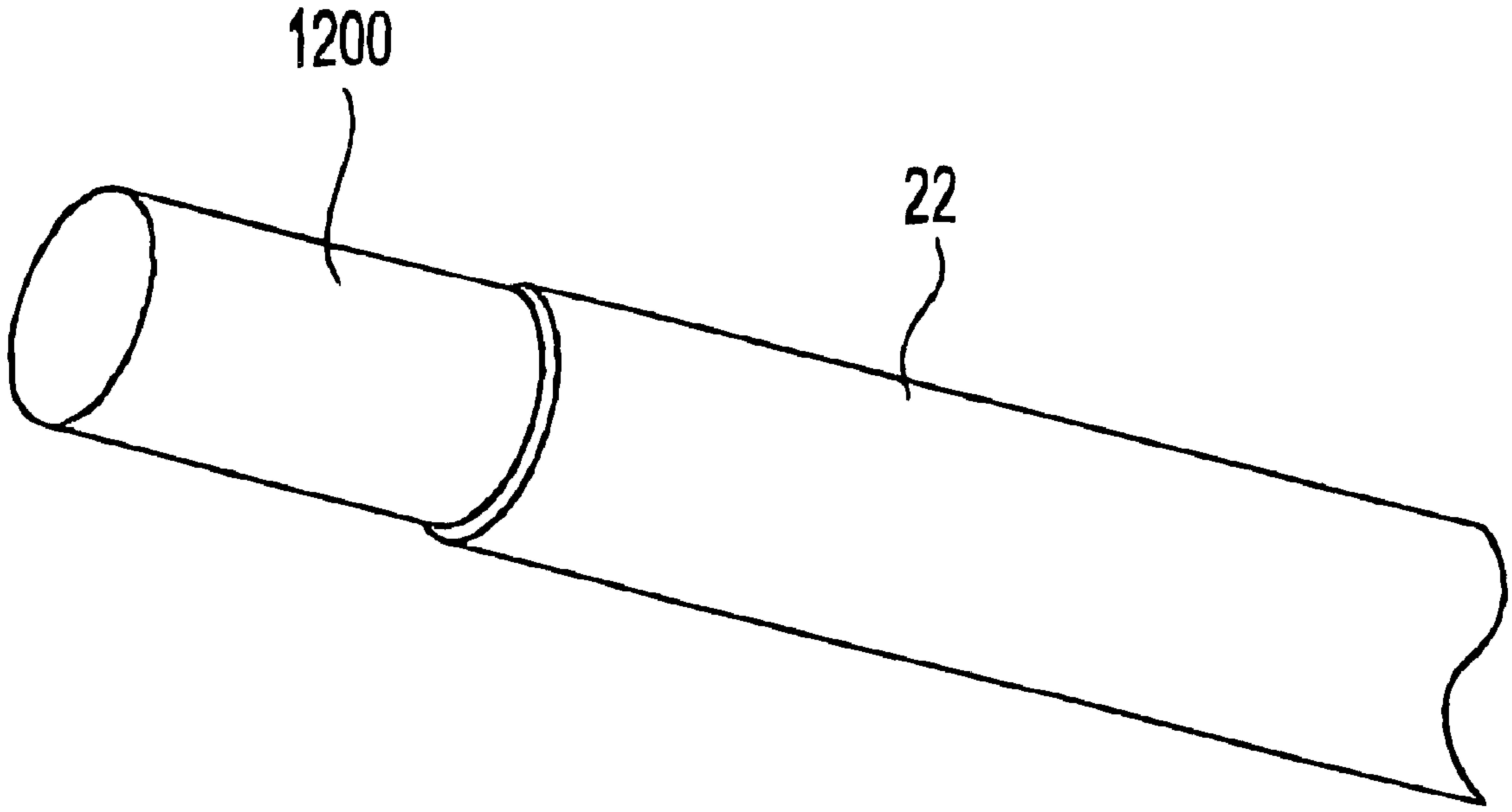

Fig. 46

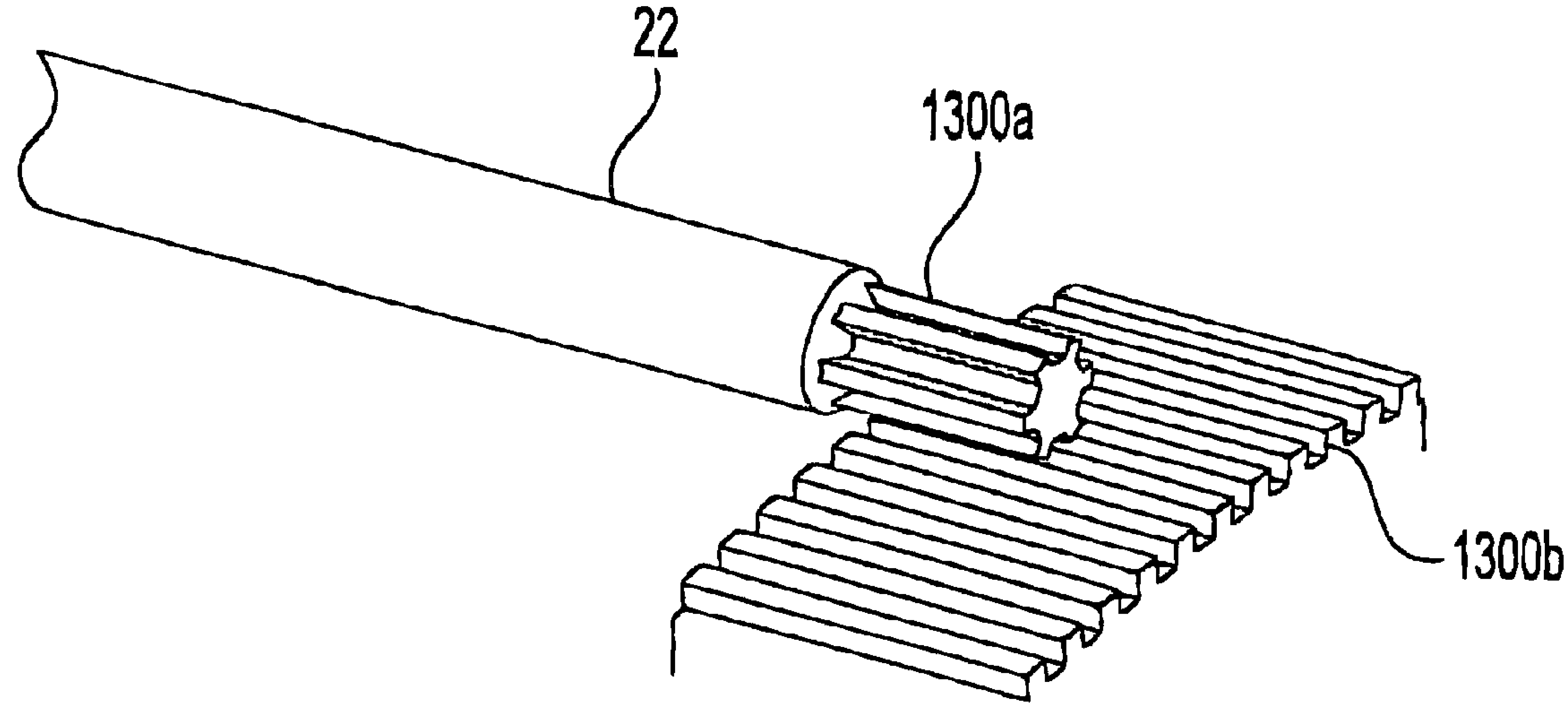

Fig. 47A

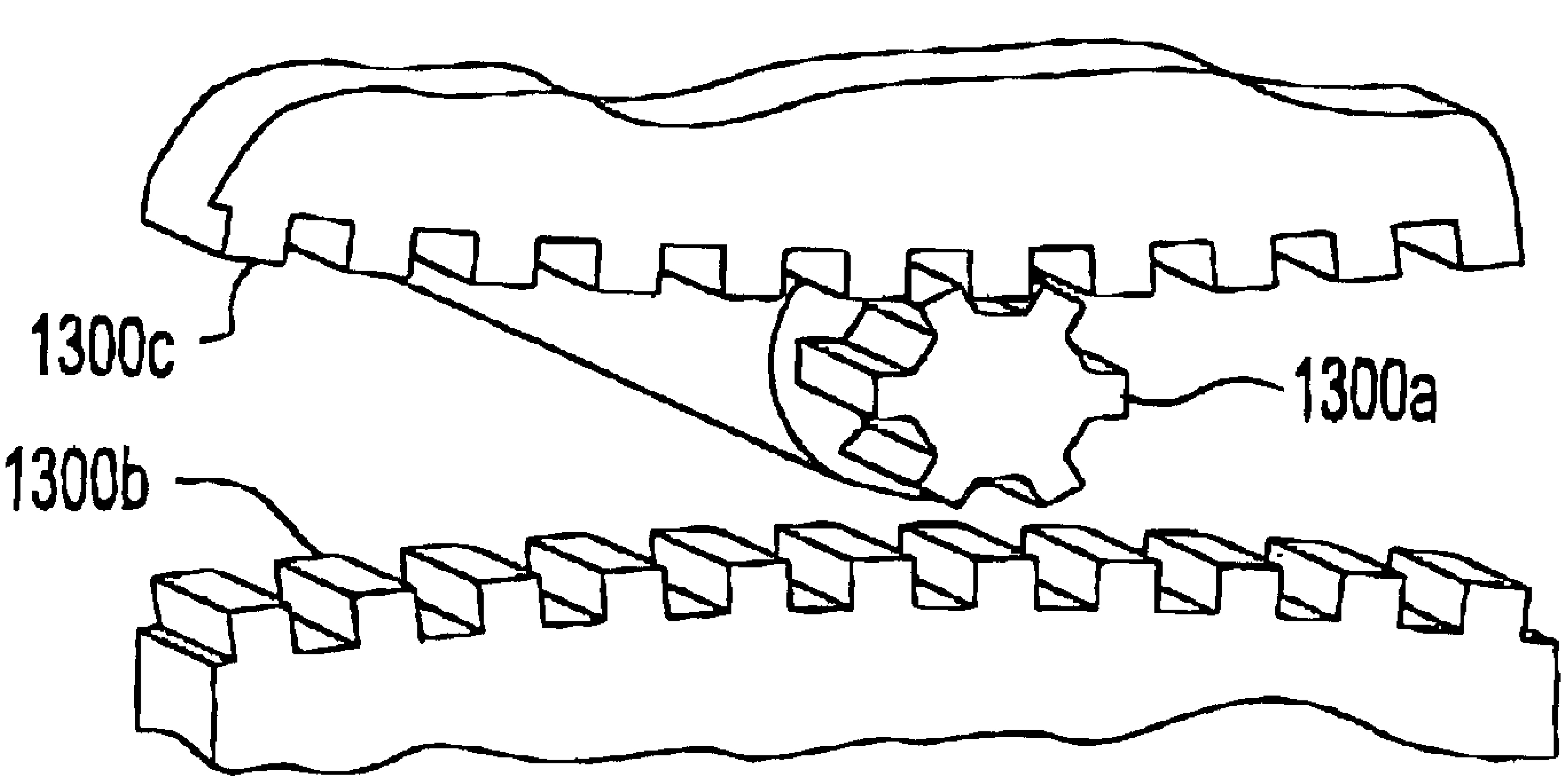

Fig. 47B

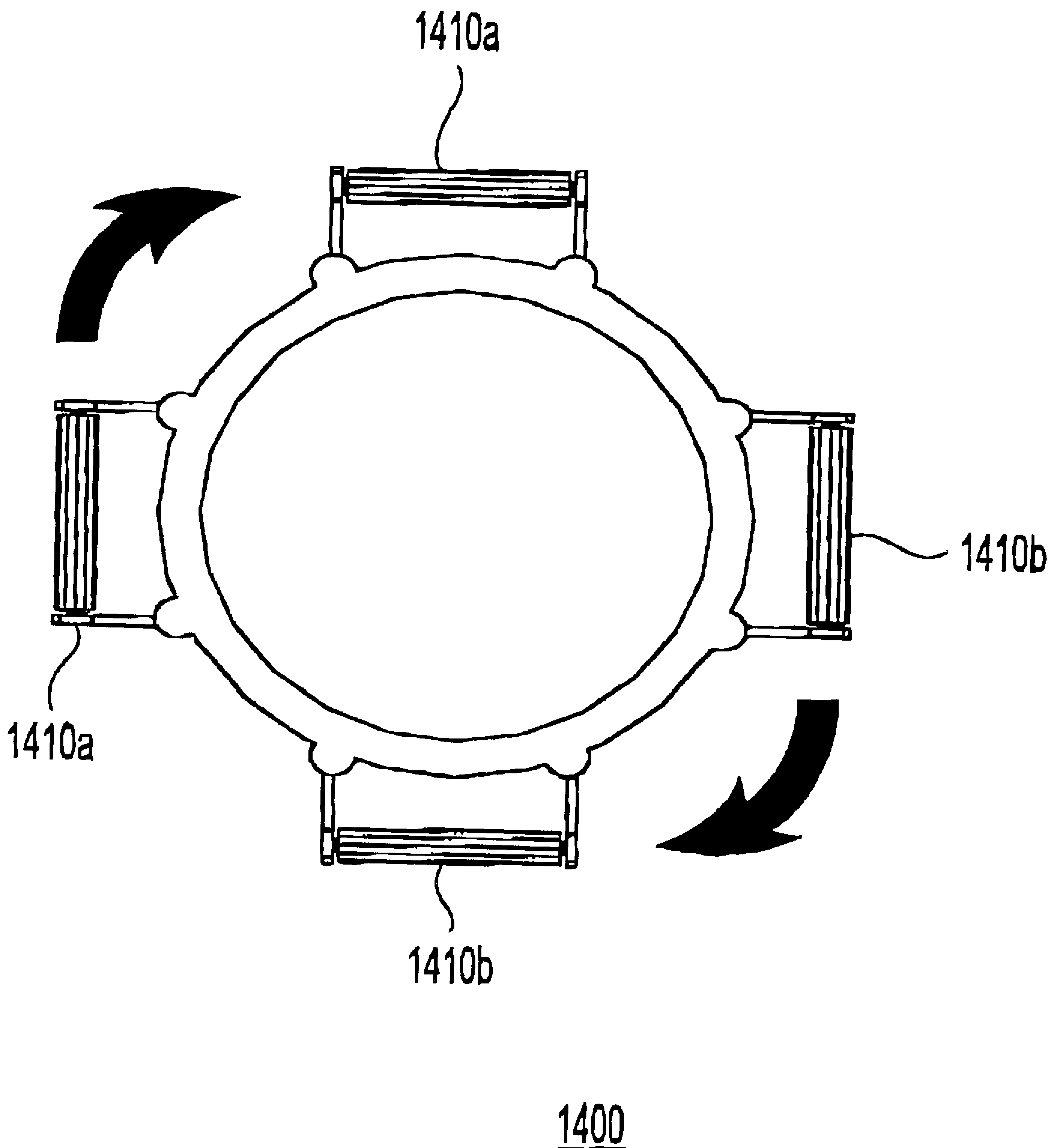

Fig. 48

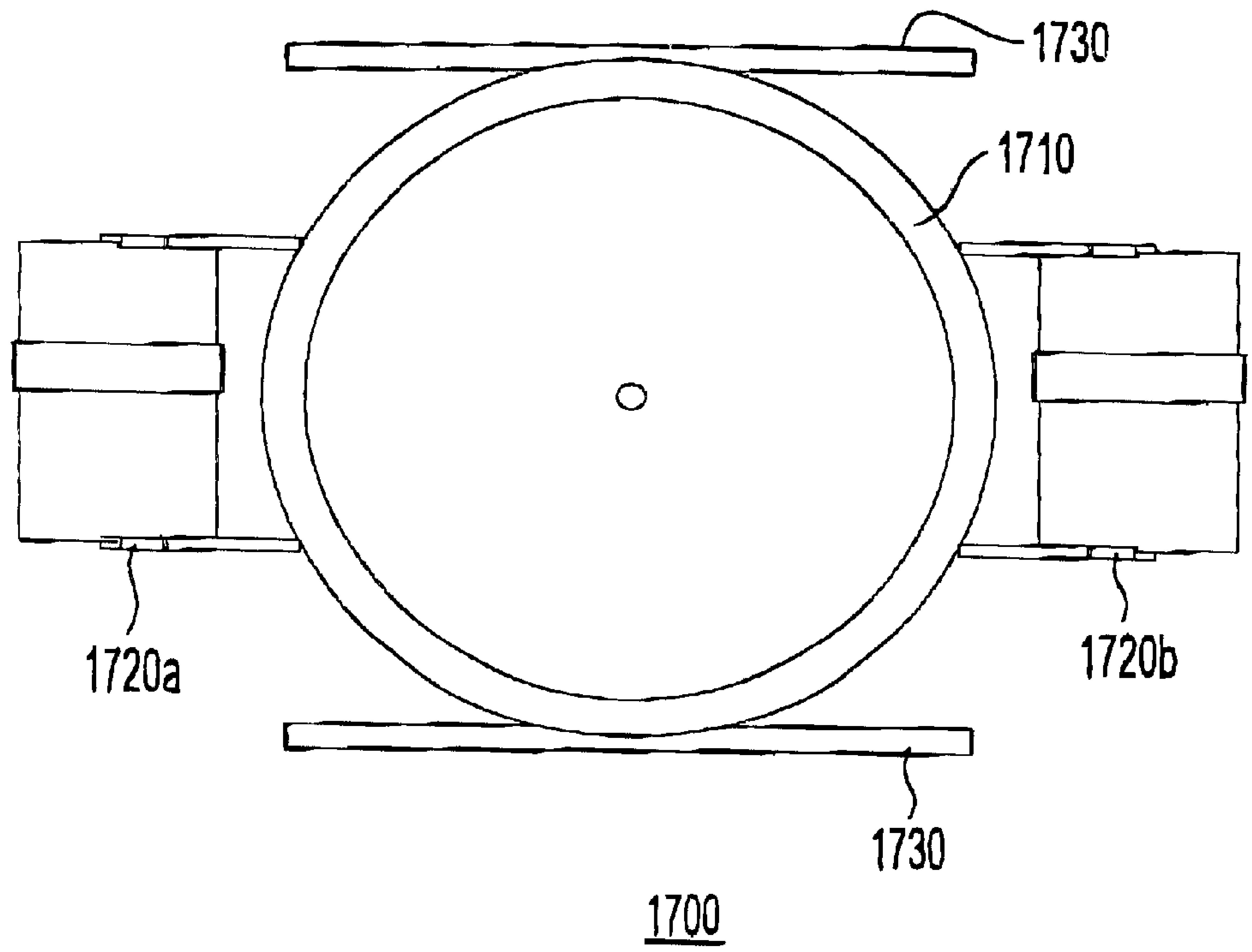

Fig. 49A

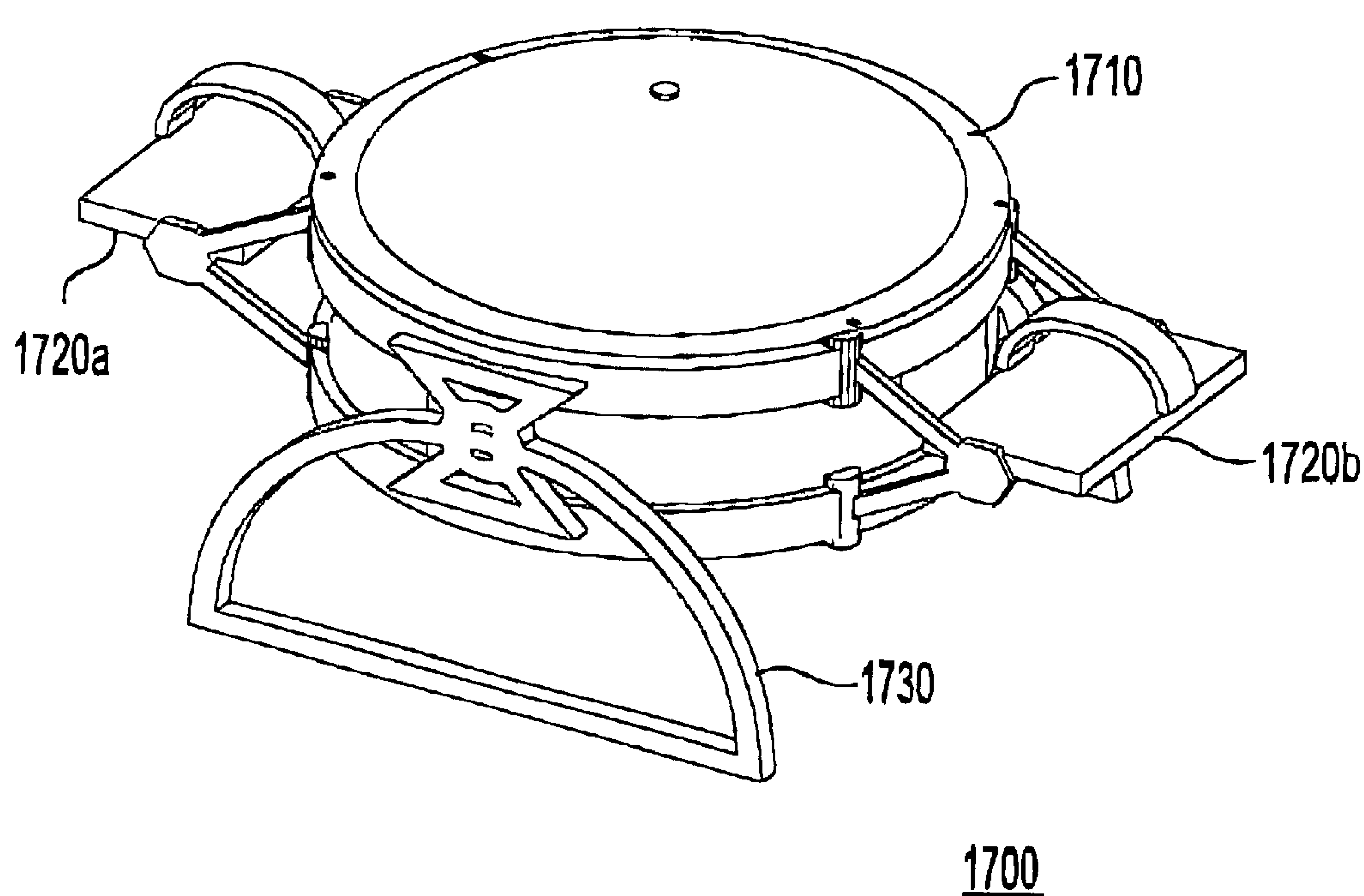

Fig. 49B

PRECESSIONAL DEVICE AND METHOD THEREOF

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to precessional devices, and particularly, to a device and method which utilize precessional forces in a controlled manner.

2. Background of the Invention

Precessional devices operate on the principle that a spinning mass, such as the rotor of a gyroscope, will resist any deflection of its rotational axis. If the rotational axis is deflected, Newton's Law of conservation of angular momentum dictates that the gyroscope will exert a precessional force at a right angle to the deflecting force. Precessional devices have performed a variety of functions in such diverse fields as navigational equipment and toys.

SUMMARY OF THE INVENTION

The present invention is briefly described as an apparatus and method of using precessional forces in a controlled manner.

In one aspect, the apparatus includes a first rotor spinning on a first spin axis and rotating around a rotational axis; and a second rotor spinning on a second spin axis and rotating around the rotational axis.

In another aspect, the apparatus includes a first rotor spinning on a first spin axis; a second rotor spinning on a second spin axis; the first rotor rotating inside a first track assembly; and the second rotor rotating inside a second track assembly.

In another aspect, the apparatus includes a first rotor spinning on a first spin axis; a second rotor spinning on a second spin axis; the first rotor rotating inside a first track assembly; the second rotor rotating inside a second track assembly; and wherein the first and second spin axes are located on substantially the same plane.

In another aspect, the apparatus includes a first rotor spinning on a first spin axis; the first rotor including first and second flywheels; and the first rotor rotating inside a support structure.

In another aspect, the apparatus includes a first rotor spinning on a first spin axis and rotating inside a first track assembly; and a second rotor spinning on the first spin axis.

In another aspect, the apparatus includes a first rotor spinning on a first spin axis; a second rotor spinning on a second spin axis; and a transmission operatively connected to said first and second rotors.

In another aspect, the apparatus includes a means for inputting a deflecting torque; and a means for substantially adding precessional torques about a first axis and substantially canceling precessional torques about a second axis.

In another aspect, the apparatus includes a first means for producing precessional torques along a first axis and a second axis; a second means for producing precessional torques along the first axis and the second axis; wherein the precessional torques substantially add along the first axis and substantially cancel along the second axis.

In another aspect, the apparatus includes a first means for producing precessional torques along a first axis and a second axis; a second means for producing precessional torques along the first axis and a second axis; and wherein the precessional torques create a variable resistance along said first axis.

In another aspect, the apparatus includes a first means for producing a plurality of precessional forces acting on a first track assembly; a second means for producing a plurality of precessional forces acting on a second track assembly; wherein said first and second track assemblies are connected to form a support structure; a plurality of handles mounted to the support structure; and wherein the precessional forces created by said first and second means create a variable resistance at the plurality of handles.

In another aspect, a method includes inputting a deflecting torque through a plurality of handles; and pulling and pushing against a variable resistance along one dimension.

In another aspect, the method includes rotating a first rotor around a rotational axis; and rotating a second rotor around said rotational axis in an opposite direction.

In another aspect, the method includes rotating a first rotor around a track assembly; rotating a second rotor around a second track assembly attached to the first track assembly; and creating a variable resistance along one dimension.

In another aspect, the method includes rotating a first spin axle containing a plurality of flywheels around a first track assembly; rotating a second spin axle containing a plurality of flywheels around a second track assembly in an opposite direction; and outputting a variable resistance along a first axis and substantially canceling forces acting along a second axis.

In another aspect, the method includes turning a hand crank to input a first deflecting torque to a first rotor rotating in a first direction and a second deflecting torque to a second rotor rotating in a second direction within a support structure; and grasping handles attached to said support structure and inputting a third deflecting torque against a variable resistance provided by the first and second rotors.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG.**1** is a perspective view of a precessional device in accordance with a first embodiment;

FIG. **2** is a front elevational view of the device in FIG. **1**;

FIG. **3** is a perspective view of the device in FIG. **1** with parts broken away to show internal structure;

FIG. **4**A is an exploded perspective view of details of the body of the device in FIG. **1**;

FIG. **4**B is a side view of the device in FIG. **1** showing the A—A, B—B, C—C, D—D, D'—D', E—E and E'—E' axes;

FIG. **5**A is a top perspective view of the track assemblies of the device of FIG. **1**;

FIG. **5**B is a side elevational view of the track assemblies of the device of FIG. **1**;

FIG. **5**C is a fragmentary cross-sectional side view showing the details of one of the tracks of the device of FIG. **1**;

FIG. **6** is a perspective view of one of the handles of the device of FIG. **1**;

FIG. **7**A is a perspective view of the first rotor component of the device of FIG. **1**;

FIG. **7**B is a front elevational view of the first rotor component of the device of FIG. **1**;

FIG. **7**C is a side elevational view of a flywheel of the first rotor component of FIGS. **7**A–**7**B;

FIG. **8** is a perspective detailed view of the central column of the device of FIG. **1**;

FIG. **9** is a front plan view of a yoke mount assembly of the device of FIG. **1**;

FIG. **10**A is a perspective view of a yoke component of the device of FIG. **1**;

FIG. **10**B is a cross-sectional plan view of the yoke of the device of FIG. **1** taken on line **10—10** of FIG. **10**A;

FIG. **11** is an exploded perspective detailed view of the central column of the device of FIG. **1**;

FIG. **12**A is a side view of,a first driven gear of the device of FIG. **1**;

FIG. **12**B is a top view of the first driven gear of the device of FIG. **1**;

FIG. **13**A is a side view of a first idler gear of the device of FIG. **1**;

FIG. **13**B is a top view of the first idler gear of the device of FIG. **1**;

FIG. **14** is a side view of a wire brace assembly of the precessional device of FIG. **1**;

FIG. **15** is a perspective view of a central hub of the precessional device of FIG. **1**;

FIG. **16** is a sectional view of the device taken along line **16—16** of FIG. **1**;

FIG. **17**A shows the device being employed by an operator to exercise in a direction directly out from the chest;

FIG. **17**B shows the device being employed by an operator to exercise in an upward angled direction;

FIG. **17**C shows the device being employed by an operator to exercise in a downward angled direction;

FIG. **18**A shows a top view of the operator with the device in a first operating position;

FIG. **18**B shows a perspective cutaway view of the device with the rotors in the first operating position;

FIG. **18**C shows a top cutaway plan view of the device with the rotors in the first operating position;

FIG. **19**A shows a top view of the operator with the device in a second operating position;

FIG. **19**B shows a perspective cutaway view of the device with the rotors in the second operating position;

FIG. **19**C shows a top cutaway plan view of the device with the rotors in the second operating position;

FIG. **20**A shows a top view of the operator's hands in relation to the forces acting on the device in a third operating position;

FIG. **20**B shows a perspective cutaway view of the device with the rotors in the third operating position;

FIG. **20**C shows a top cutaway plan view of the device with the rotors in the third operating position;

FIG. **21**A shows a top view of the operator with the device in a fourth operating position;

FIG. **21**B shows a perspective cutaway view of the device with the rotors in the fourth operation position;

FIG. **21**C shows a top cutaway plan view of the device with the rotors in the fourth operating position;

FIG. **22**A shows a top view of the operator with the device in a fifth operating position;

FIG. **22**B shows a perspective cutaway view of the device with the rotors in the fifth operating position;

FIG. **22**C shows a top cutaway plan view of the device with the rotors in the fifth operating position;

FIG. **23**A shows a top view of the operator with the device in a sixth operating position;

FIG. **23**B shows a perspective cutaway view of the device with the rotors in the sixth operating position;

FIG. **23**C shows a top cutaway plan view of the device with the rotors in the sixth operating position;

FIG. **24**A shows a top view of the operator with the device in a seventh operating position;

FIG. **24**B shows a perspective cutaway view of the device with the rotors in the seventh operating position;

FIG. **24**C shows a top cutaway plan view of the device with the rotors in the seventh operating position;

FIG. **25**A shows a top view of the operator with the device in an eighth operating position;

FIG. **25**B shows a perspective cutaway view of the device with the rotors in the eighth operating position;

FIG. **25**C shows a top cutaway plan view of the device with the rotors in the eighth operating position;

FIG. **26**A shows a top view of the operator with the device back in the first operating position and a cycle completed;

FIG. **26**B shows a perspective cutaway view of the device with the rotors back in the first operating position;

FIG. **26**C shows a top cutaway plan view of the device with the rotors back in the first operating position;

FIG. **27**A illustrates the first and second rotors rotating in first and second planes;

FIG. **27**B shows a top cutaway view of the first rotor as it transitions between the first position and the second position (for example purposes) and rotating in a clockwise direction;

FIG. **27**C shows a top cutaway view of the second rotor as it transitions between the first position and the second position (for example purposes) and rotating in a counter-clockwise direction;

FIG. **27**D shows a diagram of the torque about axis B generated by the first and second rotors compared on the same graph over time;

FIG. **27**E shows a diagram of the net torque about axis B generated by the rotors and the operator on the same graph over time;

FIG. **27**F shows a diagram of the torque about axis C generated by the first and second rotors compared on the same graph over time:

FIG. **27**G shows a diagram of the net torque about axis C generated by the rotors and the operator on the same graph over time;

FIG. **27**H–**27**J disclose a method of operation of the precessional device;

FIG. **28** is a sectional view of a second embodiment of the precessional device shown in FIG. **1**;

FIG. **29** shows the device being employed by an operator to exercise in a curling motion;

FIG. **30**A shows the operator's hands in relation to the forces acting on the device in a first location;

FIG. **30**B shows an isometric cutaway view of the device with the rotors in the first location;

FIG. **30**C shows a top cutaway plan view of the device with the rotors in the first location;

FIG. **31**A shows the operator's hands in relation to the forces acting on the device in the second location;

FIG. **31**B shows an isometric cutaway view of the device with the rotors in the second location;

FIG. **31**C shows a top cutaway plan view of the device with the rotors in the second location;

FIG. **32**A shows the operator's hands in relation to the forces acting on the device in the third location;

FIG. **32**B shows an isometric cutaway view of the device with the rotors in the third location;

FIG. **32**C shows a top cutaway plan view of the device with the rotors in the third location;

FIG. **33**A shows the operator's hands in relation to the forces acting on the device in the fourth location;

FIG. **33**B shows an isometric cutaway view of the device with the rotors in the fourth location;

FIG. **33**C shows a top cutaway plan view of the device with the rotors in the fourth location;

FIG. **34**A shows the operator's hands in relation to the forces acting on the device in the fifth location;

FIG. **34**B shows an isometric cutaway view of the device with the rotors in the fifth location;

FIG. **34**C shows a top cutaway plan view of the device with the rotors in the fifth location;

FIG. **35**A shows a top cutaway plan view of the first rotor as it transitions between the first and second location and rotating in a clockwise direction;

FIG. **35**B shows a top cutaway plan view of the second rotor as it transitions between the first and second location and rotating in a counter-clockwise direction;

FIG. **35**C shows a diagram of the torque about the B axis generated by the first and second rotors compared on the same graph over time;

FIG. **35**D shows a diagram of the net torque about the B axis generated by the rotors and the operator on the same graph over time;

FIG. **35**E shows a diagram of the torque about axis C generated by the first and second rotors compared on the same graph over time;

FIG. **35**F shows a diagram of the net torque about axis C generated by the rotors and the operator on the same graph over time;

FIG. **36** illustrates a third embodiment of the precessional device in a perspective view with the housing broken away to show internal structure;

FIG. **37**A shows a perspective view of a fourth embodiment of the precessional device with the housing broken away to show internal structure;

FIG. **37**B shows a top plan view of the fourth embodiment of the precessional device;

FIG. **37**C shows a handcrank to be used with the fourth embodiment;

FIG. **37**D shows a front perspective sectional view of the fourth embodiment of the precessional device taken along line **37**—**37** in FIG. **37**B;

FIG. **37**E shows an exploded view of the fourth embodiment of the precessional device;

FIG. **38**A is a perspective view of a fifth embodiment of the precessional device with the housing broken away to show internal structure;

FIG. **38**B is a top plan view of the fifth embodiment of the precessional device;

FIG. **38**C is a bottom perspective view of the fifth embodiment of the precessional device;

FIG. **38**D is a sectional view of the fifth embodiment taken along line **38**—**38** of FIG. **38**B;

FIG. **39** is a perspective fragmentary view of a sixth embodiment of the precessional device illustrating an alternative hand crank assembly;

FIGS. **40**A–**40**B are perspective fragmentary views of a seventh embodiment of the precessional device illustrating an electric starter;

FIG. **41** is a perspective view of an eighth embodiment of the precessional device featuring flywheels with fins;

FIG. **42**A is a perspective view of a ninth embodiment of the precessional device featuring flywheels with detachable weights;

FIG. **42**B is a perspective view of a detachable weight of the ninth embodiment;

FIGS. **43**A–**43**C are views of the tenth embodiment of the precessional device featuring expandable flywheels;

FIG. **44**A is a perspective view of an eleventh embodiment of the precessional device illustrating a braking mechanism;

FIG. **44**B is a fragmentary view of the eleventh embodiment of the precessional device illustrating in detail the braking mechanism;

FIG. **45** is a twelfth embodiment of the precessional device featuring a monitoring device;

FIG. **46** discloses a thirteenth embodiment of the precessional device featuring a modified axle tip;

FIGS. **47**A–**47**B disclose a fourteenth embodiment of the precessional device featuring an alternative modified axle tip;

FIG. **48** illustrates a top plan view of a fifteenth embodiment of the precessional device with detachable handles;

FIG. **49**A illustrates a top plan view of a sixteenth embodiment of the precessional device mounted on a stand; and

FIG. **49**B illustrates a perspective view of the sixteenth embodiment of the precessional device mounted on a stand.

DESCRIPTION OF THE PREFERRED EMBODIMENTS OF THE INVENTION

The precessional device **8** shown in FIG. **1** and FIG. **2** is a first embodiment which includes a first housing **10** and a second housing **12**, both of which provide structural support to the device and act as protective shields for the internal mechanisms. The housings **10** and **12** may be made of a thermoplastic to provide lightness and strength and may be made transparent to allow the internal mechanisms to be visible to the operator. FIG. **2** also shows a removable handcrank **9** which is used to start the precessional device.

FIG. **3** illustrates the precessional device **8** with housings **10** and **12** removed, each housing attaching directly to one of two, identical, stacked track assemblies **14** and **15**. The handcrank **9** is inserted into crank pin **13** and is then turned by the operator to start first and second rotors **120**, **121** turning in opposite directions. When the first and second rotors **120**, **121** are at their operating speed the handcrank **9** may be removed by the operator. FIG. **4**A shows an exploded isometric view of the precessional device **8**. Housings **10** and **12** are attached to track assemblies **14** and **15** through a plurality of bolts **11**. The two track assemblies **14** and **15** are rigidly locked together, a few inches apart, by a plurality of track supports **16** as shown in FIGS. **5**A and **5**B. The track assemblies **14**, **15** with supports **16** and handle brackets **18** form a support structure for axles **22** and **23**. Track assembly **15** includes elements **15***a*–**15***e* which enclose race or channel **19** (shown in FIG. **3**). A first laminate **15***b* is attached to a first track half **15***a* and a second laminate **15***d* is attached to a second track half **15***e*. Reference numeral **15***c* represents a spacer which divides the first laminate **15***b* and the second laminate **15***d*. FIG. **5**C illustrates track assembly **15** in detail. Axle tips **23***a* and **23***b* of spin axle **23** travel in a circular path between the first and second laminates **15***b* and **15***d*. The first track half **15***a*, the second track half **15***e*, and the spacer **15***c* may be made of aluminum. The first and second laminates **15***b*, **15***d* may be replaced by using rubber O-rings or other similar materials. The choice of materials used inside the first and second track halves **15***a*, **15***e* is preferably selected to reduce the possibility that the speed of the spinning axles may cause the material to be burned out or cause the axle tips **23***a* and **23***b* to skip within the track assembly **15**. Axle tips **22***a* and **22***b* travel inside a race or channel **17** in track assembly **14** which is composed similarly to track assembly **15**.

FIG. **4**A illustrates that handle brackets **18** are mounted to track supports **16** and support two handles **20***a*–**20***b* diametrically aligned relative to the planes of the track assemblies **14**, **15**. As discussed above, the handle brackets **18** also assist in the support of the two track assemblies **14**, **15**. The handles **20***a*–**20***b* are mounted to the brackets **18** as shown in FIG. **6** so that they can freely rotate about their lengthwise handle axes.

As further shown in FIGS. **3** and **4**A, track assembly **14** provides a first race or channel **17** into which the tips or distal ends **22***a* and **22***b* of the axle **22** are supported when axle **22** is inserted diametrically across track assembly **14**. The axle **22** will travel in a rotational pattern around rotational axis A—A (as shown in FIG. **4**B) within the race **17**. Axle **22** is a first spin axle which supports a first pair of flywheels **24***a* and **24***b*. FIGS. **7**A and **7**B show the flywheels **24***a* and **24***b* mounted on the first axle **22** to form the first rotor **120**. FIG. **7**C shows a detailed view of flywheel **24***a*. Flywheels **24***a* and **24***b* are substantially identical in size and mass and are mounted and balanced on the first axle **22**. FIGS. **3** and **4**A illustrate that track assembly **15** provides the second race or channel **19** into which the tips **23***a* and **23***b* of second axle **23** may be supported when axle **23** is inserted diametrically across track assembly **15**. The axle **23** will travel in a rotational pattern within the race **19** around rotational axis A—A in a direction opposite to that of axle **22**. The reason for this will be discussed in detail below. Axle **23** is a second spin axle which supports a second set of flywheels **25***a* and **25***b* to form a second rotor **121**. Flywheels **25***a* and **25***b* are substantially identical to flywheels **24***a* and **24***b* and are mounted and balanced in the same manner as flywheels **24***a* and **24***b*. Flywheels **25***a* and **25***b* may be positioned farther apart on axle **23** than corresponding flywheels **24***a* and **24***b* on axle **22**. The wider spacing allows the overall height of the precessional device **8** to be made more compact since the first and second rotors **120** and **121** may rotate without colliding. Each of the flywheels **24***a*–**24***b* and **25***a*–**25***b*, given their fixed mass, are designed to maximize rotational inertia about their respective axles **22** and **23**. The flywheels **24***a*–**24***b* and **25***a*–**25***b* may be designed to use a dense material, such as metal, especially along the outer circumference to help maximize rotational inertia. The rotational inertia of each of the first and second axles **22** and **23**, including respective flywheels, is substantially identical. FIG. **4**A further illustrates that axles **22** and **23** are supported by first yoke mount assembly **54** and second yoke mount assembly **56** respectively.

FIG. **4**B illustrates that both first and second axles **22** and **23** rotate around rotational axis A—A. Axis B—B (first orthogonal axis) and axis C—C (second orthogonal axis) are both orthogonal to the rotational axis A—A and orthogonal to each other. Axis C—C runs substantially through the center of each of the handles **20***a* and **20***b* (not shown in FIG. **4**B). Axes D'—D' and E'—E' are the spin axes for rotors **120** and **121** respectively. Axes D—D and E—E are substantially parallel to each other and to axis C—C. Spin axis D'—D' is canted with respect to axis D—D by a narrow angle a which is sufficient to keep axle tips **22***a* and **22***b* in contact with the laminates inside track assembly **14** (e.g., α may be approximately 0.5 degrees). Spin axis E'—E' is also canted by angle a with respect to axis E—E to keep axle tips **23***a* and **23***b* in contact with the laminates **15***b* and **15***d* inside track assembly **15**. Axles **22** and **23** are positioned substantially along spin axes D'—D' and E'—E' respectively. Angles D'—D' and E'—E' are canted with respect to axes D—D and E—E to control the direction of rotation of the axles **22** and **23** about D'—D' and E'—E' respectively. As will be discussed in further detail below, axle tips **22***a*–**22***b* and **23***a*–**23***b* will be in contact with the races **17** and **19** so that when the rotors **120** and **121** turn, frictional contact with the races **17** and **19** will begin to spin the axles **22** and **23**. Axles **22** and **23** will begin to produce precessional forces that will allow operation of the device **8**.

FIG. **8** illustrates the central column **50** which is substantially aligned with the rotational axis A—A around which rotors **120** and **121** turn. Central column **50** includes a first yoke mount assembly **54**, a second yoke mount assembly **56**, and a transmission **80**. The first yoke mount assembly **54** includes the first yoke **54***a* and a first yoke mount **54***b*. The second yoke mount assembly **56** includes the second yoke **56***a* and a second yoke mount **56***b*. Yokes **54***a* and **56***a* are, respectively, supported in first yoke mount **54***b* and second yoke mount **56***b*. FIGS. **9** and **10**A–**10**B show first yoke assembly **54** and yoke **54***a* in detail. Screw **54***i*, mounted in screw hole **54***j*, holds the first yoke **54***a* in position. By adjusting screws **54***d* and **54***e* in yoke holes **54***g* and **54***h*, the ends of yoke **54***a* may be preloaded or canted off axis D—D and aligned with D'—D' as previously discussed with respect to FIG. **4**B. This, in turn, adjusts the position of the axle tips **22***a*–**22***b* within race **17** in track assembly **14**. Second yoke **56***a* and axle tips **23***a*–**23***b* are adjusted in a similar manner using screws **56***d* and **56***e* (as shown in FIG. **16**). The first yoke mount upper portion **54***f* is supported by the bearing **71***a* located in the bearing mount **70***a* that is attached securely to the housing **10** (as shown in FIG. **4**A). The second yoke mount **56***b* is similarly attached to the bearing **71***b* located in the bearing mount **70***b* that is also attached securely to the housing **12**. Both mounts incorporate a plurality of e-clips **72** to maintain stability.

Between the first and second yoke mounts **54***b* and **56***b*, and solidly connected to both is the transmission **80** as shown in FIG. **8**. The function of the transmission **80** is to create a counter-rotating direct connection between the first and second yokes **54***a* and **56***a* and the axles **22** and **23** they support. FIGS. **11**–**13**B illustrate that the transmission **80** is made up of two drive (or first) gears **82***a* and **82***b* that are solidly connected to the first and second yoke mount assemblies **54** and **56** and two idler (or second) gears **84***a* and **84***b* that passively transmit torque between the drive gears **82***a* and **82***b*. In the center of the transmission **80** is a central hub **86** that fixes the gears **82***a*–**82***b* and **84***a*–**84***b* in place while allowing the gears **82***a*–**82***b* and **84***a*–**84***b* the freedom to rotate as designed. The central hub **86** is connected to the idler gears **84***a*–**84***b* via e-clips **72** and first and second gear hubs **88***a*–**88***b* as shown in FIG. **11**. The central hub **86** is connected to the drive gears **82***a* and **82***b* via first and second sleeves **90***a* and **90***b*. The central hub **86** is also connected to first and second wire brace assemblies **92** and **93** as shown in FIG. **4**A. Wire brace assemblies **92** and **93** fix the orientation of the central hub **86**. Wire brace assembly **92** includes wire brace **92***a* and wire brace mount **92***b*. Wire brace assembly **93** includes wire brace **93** a and wire brace mount **93***b*. Each of the wire braces **92***a*, **93***b* are solidly fixed to diametrically opposite track supports **16** through wire brace mounts **92***b* and **93***b* (as shown in FIGS. **3** and **4**A) and formed such that they will not interfere with the swept path of the flywheels **24***a*, **24***b* as they rotate about the rotational axis A—A. A detailed view of the wire brace assembly **92** is shown in FIG. **14**. FIG. **15** shows a perspective view of central hub **86**. Reference numeral **86***a* represents a wire form hole to receive a stabilizing wire brace **92***a* or **93***a*; reference numeral **86***b* represents a gear hub hole to receive a gear hub; and reference numeral **86***c* represents a sleeve hole to receive a sleeve. Holes **86***a*, **86***b*, and **86***c* have corresponding holes on the other side of the hub **86** which are not shown.

FIG. **11** shows axle crank pin **13** which is attached to the bottom of the second yoke mount assembly **56** and which may receive the end of a removable hand crank **9** (as shown in FIG.**2**). When one of the driven gears **82***a* or **82***b* is turned, it causes the two idler gears **84***a* and **84**b, axially fixed in space due to the two wire braces **92***a* and **93***b*, to rotate. The idler gears **84***a*, **84***b*, in turn, cause the other driven gear **82***a* or **82***b* to rotate in an opposite direction to gear **82***a* or **82***b*. Gears **82***a*–**82***b* and **84***a*–**84***b*, have the same number of teeth (as shown in FIGS. **12**A–**13**B) and therefore rotate substantially at the same rate. Due to the direct connections between driven gears **82***a* and **82***b*, yoke mounts **54***a* and **56***a* and yokes **54***b* and **56***b*, rotation of one axle **22** or **23** about the rotational axis A—A requires the counter-rotation of the other axle **22** or **23** about the rotational axis A—A

FIG. **16** illustrates the precessional device in a starting position. FIG. **16** is a sectional view along line **16**—**16** of FIG. **1**. FIG. **16** further illustrates that by adjusting the screws **54***d* and **54***e* the first axle **22** may be positioned so that one tip **22***a* is pressing in one direction in the track race **17** and one tip **22***b* is pressing in the opposite direction in the track race **17**. By adjusting the screws **56***d* and **56***e* the second axle **23** can be positioned so that one tip **23***a* is pressing in one direction in the track race **19** and one tip **23***b* is pressing in the opposite direction in the track race **19**. Due to surface friction between the tips **22***a*–**22***b* and **23***a*–**23***b* of the axles **22** and **23** and the races **17** and **19** rotation of the rotors **120** and **121** about the axis rotational A—A induces spin of the axles **22**, **23** about the spin axes D'—D' and E'—E'. This spin includes the flywheels **24***a*–**24***b* and **25***a*–**25***b*. Once again, the central column **50** allows each axle **22** and **23** to spin independently about their respective spin axes. However, rotation about the rotational axis A—A of one rotor is mechanically linked to the counter-rotation of the other rotor about the same rotational axis A—A. Since the rotation about the A—A axis is driving the spin of the flywheels through frictional contact with races **17** and **19**, the spin rate of each of the rotors **120** and **121**, in absolute terms, is substantially the same at all times.

As shown in FIGS. **4**B and **16**, the axles **22** and **23** are assembled so that they can align almost parallel (except for the canting by angle α) to the axis C—C running through handles **20***a* and **20***b*. The screws **54***d*–**54***e* and **56***d*–**56***e* are set so that, in this first embodiment the axles **22** and **23** are tilted or preloaded in the same direction so that they are substantially parallel to each other. In FIG. **16**, the axle tips on the right side **22***a*, **23***a* are in contact with the first side of their respective races **17** and **19** while the axle tips **22***b*, **23***b* on the left side of FIG. **16** are in contact with the second or opposite side of their respective races **17** and **19**.

When the hand crank **9** is rotated in a clockwise direction (as shown in FIG. **2**), the second axle **23** and second pair of flywheels **25***a*–**25***b*, which form the second rotor **121**, begin to rotate in a clockwise direction. This in turn causes the second axle **23** to spin due to the frictional contact of the axle tips **23***a* and **23***b* with the race **19**. Likewise the first axle **22** and first flywheels **24***a*–**24***b*, which form the first rotor **120**, begin to rotate in the opposite counter-clockwise direction. This causes the first rotor axle **22** to spin axially as well since axle tips **22***a* and **22***b* are in frictional contact with race **17**.

As the clockwise rotation of the hand crank **9** continues the first and second rotors' spin **120**, **121** continues to accelerate around both spin axes D'—D' and E'—E'. This motion continues with the second rotor **121** rotating continually in a clockwise direction around first track assembly **14** and the first rotor **120** rotating counter-clockwise around second track assembly **15**. After one revolution of the hand crank **9**, each of the rotors **120** and **121** will have rotated once around each of their respective track assemblies **14** and **15**. Assuming constant pressure on the crank **9** by the operator, each successive revolution of the hand crank **9** causes the rotors **120**, **121** to spin faster and faster. (The precessional device **8** might also be designed so that the hand crank **9** initially rotates in the counter clockwise direction).

A first method of operation of the first embodiment of the precessional device **8** is illustrated with reference to FIGS. **16**–**26**C. After manipulating the hand crank **9** and then optionally removing the handcrank **9**, the operator firmly grasps the precessional device **8** by the handles **20***a*–**20***b* as shown in FIGS. **17**A–**17**C. After a few rotations of the hand crank **9**, the axial spinning of the flywheels **24***a*–**24***b* and **25***a*–**25***b* becomes great enough to cause a detectable precessional effect to occur. Precession is the effect that a spinning mass exhibits when its axis of spin is deflected. In the precessional device **8**, the two rotors **120** and **121** represent two spinning masses with axes of spin D'—D' and E'—E'. The law of precession states that if the spin axis of a spinning mass (i.e., flywheels **24***a*–**24***b* and **25***a*–**25***b*) is deflected by a torque that is perpendicular to the spin axis, the mass will react with a precessional torque that is perpendicular to both the spin axis and the deflecting torque. In the case of precessional device **8**, first and second deflecting torques D_1 and D_2 are provided by the operator initially through the hand crank **9** turning rotors **120** and **121** during the startup time period and then during operation by the force of the operator's arms against handles **20***a* and **20***b* which creates a third deflecting torque D_3 (deflecting torques D_1, D_2, and D_3 will be discussed in further detail below).

In the precessional device **8**, as explained, the first and second rotors **120** and **121** each are "spinning masses." Rotors **120**, **121** each have two flywheels **24***a*–**24***b*, **25***a*–**25***b* mounted at different points on their respective axles to achieve a more compact design for the precessional device **8**. The pairs of flywheels are balanced and mounted such that each of the rotors **120**, **121** possess the same rotational inertia about their spin axes D'—D' and E'—E'. Rotational inertia may be explained as follows. The inertia of each of the rotors **120**, **121** about their spin axes D'—D' and E'—E', is the sum of the moments of inertia of each particle of mass in the rotor. The moment of inertia of a particle with mass m, a distance r from a spin axis, is mr^2, and the total rotational inertia of the rotor is mr_{avg}^2. By concentrating the mass of the rotors in the outer perimeter of the flywheels, the rotational inertia about the spin axes D'—D' and E'—E' may be maximized. A body is said to spin when all of its particles move in circles about a common axis with a common angular velocity (ω). As discussed above, torque applied so as to tend to change the axis about which a body is spinning results in a precession effect. Precession is explained by one of Newton's Laws of motion which states: the time rate of change of angular momentum about any given axis is equal to the torque applied about the given axis. The formula that defines the resultant torque is $T=I\omega r\Omega$, where I is the inertia of the rotor about its spin axis, the longitudinal axis formed by the length of the axle and Ω is the rate of precession. It is about each of the precession spin axes D'—D' and E'—E' that the rotors **120**, **121** achieve a spin velocity sufficient enough to precess at a detectable magnitude. By maximizing rotational inertia (I) about the spin axes D'—D' and E'E', a greater applied torque is needed to produce the same rate of precession, Ω. The position of the flywheels along the axis of the axle does not affect the distance r_{avg}, and therefore has no effect on the flywheels inertia with respect to the spin axis. Thus, assuming each flywheel is properly weighted and balanced the first rotor **120** will have the same inertia about its spin axis as the second rotor **121**. Assuming they spin at the same rate, identically applied torques will produce identical precessional torques.

FIGS. **17**A–**17**C show the precessional device **8** in three different exemplary positions that it may be used for anaerobic and aerobic exercise. FIG. **17**A shows the device **8** being pushed and pulled straight out from the chest and FIGS. **17**B and **17**C show the device **8** being operated at an angle with the same push/pull motion.

FIG. **17**A shows the operator holding the precessional device **8** in accordance with a typical method of operation. In this method of operation, the operator starts the rotors **120** and **121** moving with the hand crank **9** and then removes the hand crank **9** after the rotors **120**, **121** are up to speed. Next, the operator holds the device **8** in front of his body at chest level by the handles **20***a* and **20***b* with the right hand on handle **20***a* and the left hand on handle **20***b*. In this method, the precessional device **8** is used with the operator pushing out with one hand against a variable precessional force and pulling back with one hand against a variable precessional force. (From the perspective of the operator grasping the handles **20***a* and **20***b*, the precessional torque produced by the device **8** is perceived as a force and it is therefore convenient to use the term "net precessional force" when specifying the resistance the operator is pushing or pulling against on the handles **20***a* and **20***b*. NP_R will be used to indicate the net precessional force the operator feels acting on his right hand as he grasps handle **20***a* and NP_L will be used to indicate the net precessional force the operator feels acting on his left hand as he grasps handle **20***b*. "Total precessional torque" (TPT) will be used to indicate substantially the net precessional torque acting on the device **8** during operation due to the rotors **120** and **121**).

The first operating position, as shown in FIG. **18**A, has the operator's right arm R holding the handle **20***a* near the operator's body in a fully contracted position and the operator's left arm L holding the handle **20***b* in a fully extended position. As shown in FIGS. **18**B and **18**C, given the fixed equivalent moment of inertia (I) of each of the rotors **120** and **121**, the magnitude of the total precessional torque (TPT) produced by the device is determined by the rate of axial rotation of axes **22** and **23** in races **17** and **19**. The direction of the total precessional torque (TPT) is determined by the orientation of a deflecting torque relative to the direction of the spinning masses, flywheels **24***a*–**25***b*. As previously discussed, deflecting torques D_1 and D_2 (as shown in FIG. **18**B) are initially produced by the operator's manipulation of the crank **9** which deflects the spin axes D'—D' and E'—E' of the axles **22** and **23** containing the flywheels **24***a*–**25***b*. In turn, the deflecting torque D_1 will produce precessional torque in rotor **120** that exerts forces P**22***a* and P**22***b* through contact between the axle tips **22***a* and **22***b* and race **17** to the entire structure of the precessional device **8**. Deflecting torque D_2 will produce precessional torque in rotor **121** that exerts forces P**23***a* and P**23***b* acting through contact between axle tips **23***a* and **23***b* and race **19** to the entire structure of the precessional device **8**.

SP as shown in FIG. **18**C indicates the starting point of axle tip **22***a* and will be used as a comparison point to locate the position of axle tip **22***a* as it travels around race **17**. (Note that SP is an arbitrary starting point and the device **8** may be started with the axles **22** and **23** located in any orientation around the races **17** and **19**). At point SP, axle tip **22***a* is at 0 degrees from the starting point. S indicates the direction of spin of each of the flywheels **24***a*–**24***b* and **25***a*–**25***b*.

In the first operating position as shown in FIG. **18**A, the operator is about to begin extending the right hand and pulling or contracting with the left hand. An operator will have completed a full stroke when the right arm R is fully extended and the left arm L is fully retracted. An operator will have completed a full cycle or two strokes when the right arm is fully retracted back to the starting position and the left arm L is fully extended back to the starting position.

At the first operating position, the operator's right arm R is contracted and his left arm L is extended. This position is a momentary state of equilibrium where there are no substantial net forces being generated by the device **8** or the operator. As illustrated by FIG. **18**B, precessional forces P**22***a*, P**23***a* and P**22***b*, P**23***b* are approximately equal and in opposite directions so they will substantially cancel each other out. Therefore, the operator will not feel a net precessional force NP_R or NP_L the device **8** in either hand R or L.

FIGS. **19**A–**19**C illustrate the second operating position with axle tip **22***a* at 45 degrees from the starting point SP. FIG. **19**A shows the operator's right arm R pushing against NP_R (net precessional force on right handle) with force F_R and a quarter of the way through a stroke. At the second operating position, NP_R is equal to the sum of P**22***b* and P**23***a*. FIG. **19**A also shows the operator's left hand L pulling against NP_L (net precessional force on left handle) with force F_L and also a quarter of the way through a stroke. NP_L is equal to the sum of P**23***a* and P**23***b*.

FIGS. **20**A–**20**C illustrate the third operating position with axle tip **22***a* at 90 degrees from starting point SP. FIG. **20**A shows the operator's right and left arms R, L at positions halfway through the stroke traveling in opposite directions. NP_R is at its maximum because P**22***b* and P**23***a* are adding with substantially no cancellation effects and NP_L is also at its maximum because P**22***a* and P**23***b* are also substantially adding with no cancellation effects. Therefore, the operator is feeling maximum net precessional forces NP_R and NP_L against him in each arm at this operating position.

FIGS. **21**A–**21**C illustrate the fourth operating position with axle tip **22***a* at 135 degrees from the starting point SP. In this position the right arm R is almost fully extended and the left hand is almost fully contracted close to the body. NP_R is the sum of P**22***b* and P**23***a* and NP_L is the sum of P**22***a* and P**23***b*. NP_R and NP_L have both weakened since the third operating position.

FIGS. **22**A–**22**C illustrate the fifth operating position with axle tip **22***a* at 180 degrees from the starting point SP. In this position, the right hand R is fully extended and the left hand L is fully retracted close to the body. NP_R and NP_L are both substantially zero due to the canceling effect of P**22***a*, P**23***a* and P**23***a*, P**23***b*. Likewise, the operator is exerting substantially no force at this point of equilibrium. In this position the operator has completed a first full stroke and is about to begin a second full stroke.

FIGS. **23**A–**23**C illustrate the sixth operating position with axle tip **22***a* at 225 degrees from the starting point SP. In this position, the right arm R is pulling against precessional force NP_R with force F_R and the left hand is pushing against precessional force NP_L with force F_L. NP_R is equal to P**22***a* summed with P**23***b* and NP_L is equal to P**22***b* summed with P**23***a* (not shown in FIG. **23**B).

FIG. **24**A–**24**C illustrate the seventh operating position with axle tip **22***a* at 270 degrees from the starting point SP. In this position, the right arm R is pulling against maximum precessional force NP_R of force F_R and the left arm L is pushing against maximum precessional force NP_L with force F_L. NP_R is equal to P**22***b* summed with P**23***b* and NP_L is equal to P**22***a* summed with P**23***a*.

FIGS. **25**A–**25**C illustrate the eighth operating position with axle tip **22***a* at 315 degrees from the starting point SP. In this position, the right arm R is pulling against a lessening precessional force NP_R with force F_R and the left arm L is pushing against a lessening precessional force NP_L with force F_L. NP_R is equal to P**22***b* summed with P**23***b* and NP_L is equal to P**22***a* summed with P**23***a*.

FIGS. **26**A–**26***c* illustrate the ninth and final operating position with the axle tip **22***a* at 360 degrees. This is the same point of equilibrium as the first operating position and the operator has finished the second stroke and also completed a full cycle.

FIG. **27**A illustrates a conceptual drawing of the three-dimensional space bounded by the device **8**. The space is primarily defined by three axes A—A, B—B and C—C. The origin of the space is fixed as the central point of the transmission **86**. (The transmission **86** is not shown in the conceptual view). The origin lies equidistant between the two races **17** and **19** which are shown forming two circular rotational planes **17**' and **19**' in FIG. **27**A. As previously discussed, the axis defined by the first spinning axis **22** is labeled D'—D'. The axis defined by the second spinning axis **23** is labeled E'—E'. FIG. **27**B shows a top plan view of the first rotor **120** as it transitions between the first and second operating positions (corresponding to FIGS. **18**A–**19**C) and the rotation of axis D'—D' in relation to axes B—B and C—C. FIG. **27**C shows a top plan view of the second rotor **121** as it transitions between the first and second operating position and the rotation of axis E'—E' in relation to axes B—B and C—C (with first rotor **120** not shown).

FIG. **27**D shows a graph illustrating the precessional torques about the B—B axis (T_B) due to axle **22** (D') and axle **23** (E') plotted over time (t). The graph shows three complete cycles or revolutions of the axles **22** and **23** about axis A—A. The precessional torque due to axles **22** and **23** are substantially equal and complementing each other. Beginning with time t=0, the graph shows a sinusoidal wave with three complete cycles; each delineated top portion of the wave where $T_B>0$ represent the rotor **120** as it transitions from operating position **1** to **5** and the bottom portions of the wave where $T_B<0$ represent the device **8** as it transitions from operating positions **5** back to **1**. Therefore, when the operator is performing a push/pull routine the precessional torque about the B axis will provide a variable resistance.

FIG. **27**E shows a graph illustrating the net torques produced about axis B—B (T_B). The sum of the torques produced by axles **22** and **23** is the total precessional torque (TPT). The graph shows that the amplitude of the input of the operator which is deflecting torque D_3 is substantially equal to the output of the device **8** and the two are in an opposite phase relationship meaning that the output of one counteracts the output of the other. Disregarding the effects of surface friction and aerodynamic drag on the device **8**, if the operator's deflecting torque D_3 and the total precessional torque (TPT) were equal it would result in the device **8** having no oscillating motion and the rotors **120, 121** would maintain a constant angular velocity. Since the moving parts of the device **8** do experience energy loss from surface friction and aerodynamic drag, in order to maintain constant velocity of the rotors **120**, **121**, the operator must exert a force F_R that is greater than NP_R and F_L that is greater than NP_L. As a result, the operator effectively exerts a torque equivalent to the difference between F_R and NP_R multiplied by half the distance between the handles **20***a* and **20***b* (torque equals force times length of lever arm) and a torque equivalent to the difference between F_L and NP_L multiplied by half the distance between the handles **20***a* and **20***b* . This torque will be deflecting torque D_3, and it opposes the total precessional torque TPT. Whereas deflecting torques D_1 and D_2 deflect rotors **120** and **121** respectively, D_3 deflects both rotors **120** and **121**. D_3 causes rotor **120** to produce a precessional torque that is aligned with D_1 and causes rotor **121** to produce a precessional torque that is aligned with D_2. In this fashion, the operator's manipulation of the handles **20***a* and **20***b* accomplishes the same result in accelerating the rotation of the rotors about the A—A axis that manipulation of the hand crank **9** initially did.

FIG. **27**F shows a graph illustrating the precessional torques about the C—C axis (T_c) due to axle **22** (D') and axle **23** (E') plotted over time (t). The torques due to axles **22** and **23** cancel each other as shown by the total precessional torque about the C—C axis (TPT) in FIG. **27**G. TPT and D_3 are substantially zero about the C axis as shown by the flat line graphs. FIGS. **27**E and **27**G demonstrate that the input and output torques (D_3 and TPT) oscillate or vary substantially along one dimension only (the axis B—B). Whereas FIGS. **27**D and **27**F show the torque from each rotor **120** and **121** varying about both axes B—B and C—C, the total precessional torque (TPT) oscillates only about axis B—B. This feature of the precessional device **8** allows the operator to obtain a controlled, variable resistance exercise routine.

FIGS. **27**H–**27**J disclose a method of operation of the first embodiment. The operator turns the hand crank **9** in a first step **150**. Simultaneously in steps **152** and **154** deflecting torques D_1 and D_2 are created by the turning of the hand crank **9**. In steps **156, 158** deflecting torques D_1 and D_2 drive rotors **120, 121** around rotational axis A—A. In steps **160, 162** axle tips **22***a*–**22***b* and **23***a*–**23***b* are frictionally driven by coming into contact with races **17** and **19** of track assemblies **14** and **15**. In steps **164, 166** rotors **120** and **121** spin axially and generate precessional torques which are orthogonal to the rotational direction of the rotors. In steps **168, 170** axle tips **22***a*, **22***b*, **23***a* and **23***b* press against track assemblies **14** and **15** with precessional forces P**22***a*, P**22***b*, P**23***a* and P**23***b*, respectively. At step **172**, a decision is made whether rotors **120** and **121** are generating sufficient torque. If not, the operator will repeat the cranking of the hand crank **9**. If the rotors **120** and **121** are generating enough torque to begin a workout the operator will remove the crank **9** in step **174**. Rotors **120** and **121** continue to precess in step **176** due to angular momentum. In the next step **178**, the operator grasps precessional device **8** by handles **20***a* and **20***b*. In step **180**, the operator perceives precessional forces P**22***a*, P**22***b*, P**23***a* and P**23***b* as varying net precessional forces NP_L and NP_R at handles **20***a* and **20***b*. In step **182**, the operator exerts forces F_R and F_L against net precessional forces NP_R and NP_L. In step **184**, the forces F_R and F_L applied by the operator are compared to the net precessional forces NP_R and NP_L. If the net precessional forces NP_R and NP_L are greater than the operator's applied forces F_R and F_L, the rotors **120** and **121** decrease (step **186**) and the operator will have to input greater force to maintain the intensity of the exercise routine. Third deflecting torque D_3 is applied by the operator on rotors **120** and **121** (step **188**). Rotor **120** will generate a precessional equivalent to D_1 and rotor **121** will generate a precessional torque substantially equivalent to D_2

(step **190**). Rotors **120** and **121** continue to accelerate and the operator performs the exercise routine (**192**).

FIG. **28** shows a second embodiment of the precessional device **8** shown in FIG. **1**. In the second embodiment, the precessional device **8** is adjusted so that an exercise involving a curling motion with the arms can be performed. Essentially, whereas the total precessional torque (TPT) oscillated or varied about axis B—B in the first embodiment, the total precessional torque (TPT) oscillates about axis C—C in the second embodiment. The adjustment is made by adjusting the screws **56***d* and **56***e* as shown in FIG. **28** so that axle **23** tilts opposite to the direction of the first method of operation as shown in FIG. **16**. By changing the tilt of the axle **23** and thereby changing the direction of the deflecting torque D_3 provided by the operator, the precessional force will also be changed from the first method of operation.

FIG. **29** discloses an operator using the precessional device **8** to perform a curling exercise. The device **8** will function similarly to the first method of operation except for the direction of the precessional forces felt at the handles **20***a* and **20***b*.

FIGS. **30**A–**30**C show the device **8** in a first location or starting position. After starting the device using the hand crank **9**, the operator again grasps the precessional device **8** by handles **20***a* and **20***b*. The precessional torques are canceling each other about the axis B—B and axis C—C. The device is at a momentary state of equilibrium and the operator is about to begin the stroke upwards.

FIGS. **31**A–**31**C show the device in a second location and the operator has completed a quarter of a stroke.

FIGS. **32**A–**32**C show the device in a third location and the operator has completed half of a stroke.

FIGS. **33**A–**33**C show the device in a fourth location and the operator has completed three quarters of a full stroke.

FIGS. **34**A–**34**C show the device in a fifth location and the operator has completed a full stroke and half of a cycle. To complete a full cycle the operator will return the device **8** to the starting position.

FIG. **35**A shows a top plan view of the first rotor **120** as it transitions between the first and second location and the rotation of axis D'—D' in relation to axes C—C and B—B. FIG. **35**B shows a top plan view of the second rotor **121** and axis E'—E' as they transition between the first and second locations with first rotor **120** removed. FIG. **35**C shows the torques about axis B—B due to axle **22** (D') and axle **23** (E') canceling each other out. The sum of the torques due to axle **22** and axle **23** is shown by total precessional torque (TPT) in FIG. **35**D, and the torque generated by the operator along axis B—B is identified as D_3 as before. FIG. **3 5**E illustrates the torques of the axles **22** and **23** about the C axis. As can be seen from the graph, the torques due to axle **22** (D') and that due to axle **23** (E') are complementary. FIG. **35**F shows the total precessional torque TPT and D_3 compared over time as in FIG. **35**D. FIGS. **35**C–**35**F illustrate that TPT and D_3 oscillate or are variable about Axis C—C in the second embodiment, whereas they oscillated about axis B—B in the first embodiment.

FIG. **36** illustrates a perspective view of a third embodiment of the precessional device which is labeled **200**. In this embodiment, the precessional device **200** features an alternative method of configuring the tracks. Whereas the first embodiment uses two tracks vertically aligned about a central rotational axis, the third embodiment **200** discloses two tracks that are concentric and coplanar to obtain a more compact device. However, the third embodiment operates based on the same principles as the first and second embodiments. The third embodiment also employs a pair of handles, a start-up mechanism and enclosure (not shown) similar to the first and second embodiments.

FIG. **36** discloses an outer track assembly **215** including a race **217** in which axles **222***a* and **222***b* rotate. The opposite end of axle **222***a* is mounted in bearings **232**. The opposite end of axle **222***b* is also mounted in bearings (not shown). Mounted on axles **222***a* and **222***b* are outer flywheels **225***a* and **225***b*. Flywheel **225***a* is mounted on the first outer axle **222***a* and flywheel **225***b* is mounted on the second outer axle **222***b*. Located on inner axle **223** are inner flywheels **224***a* and **224***b*. Inner axle **223** travels inside race **219** in track assembly **214**. Support arm **230** provides structural stability to outer axes **222***a* and **222***b*. Support arm **230** is attached to a central transmission **235** which allows the first rotor **240** to rotate in a counter-clockwise direction and the second rotor **242** to rotate in a clockwise direction. Bearings **237** connect the transmission to **235** batteries **233**. Batteries **233** provide an alternative method of starting the device besides using a handcrank. Note that wire brace assemblies used to support the transmission **235** and a supporting device for track assembly **214** are not shown. Due to the different diameter of the outer and inner track assemblies **214** and **215**, the diameter of the outer and inner axles must vary in the same proportion so that the inner and outer flywheels **224***a*, **224***b* and **225***a*, **225***b* spin at the same rate. The method of operation of the third embodiment will be very similar to that of the first and second embodiments.

FIGS. **37**A–**37**E disclose a fourth embodiment **300** of the precessional device in which the track assemblies **314** and **315** are non-concentric and coplanar. Attached to the precessional devices are handles **320**. In the center of the track assembly **314** is rotor **324**. Rotor **324** spins on axle **322**. Rotor tips **322***a* and **322***b* are frictionally driven inside race **360**. Axle **322** is attached to bearings **334***c* and **335***c* which turn inside support assemblies **334** and **335**, respectively. Support assembly **334** is attached to plate portion **330***a* of a first circular gear **330** through attachment pieces **334***a* and **334***b*. Support assembly **335** is attached to plate portion **330***b* of the first circular gear **330** through attachment pieces **335***a* and **335***b*. In the center of track assembly **315** is rotor **325**. Rotor **325** spins on axle **323**. Axle tips **323***a* and **323***b* are frictionally driven inside race **361**. Axle **323** is attached to bearings **336***c* and **337**c which turn inside support assemblies **336** and **337**, respectively.

The fourth embodiment **300** operates on the same principles as the first and second embodiments. A hand crank as shown in FIG. **37**C is inserted into pin hole **340** in FIG. **37**A and is used to start the second circular gear **332** turning. Second gear **332** in turn causes first circular gear **330** to rotate. As the circular gears **330**, **332** turn, the axle tips **322***a*, **322***b*, **323***a*, and **323***b* are frictionally driven by coming into contact with the races **360** and **361**. In turn, rotors **324** and **325** begin turning. The total precessional torque produced by the rotors **224** and **225** will then buildup a variable resistance. The method of operation of the fourth embodiment will be similar to that of the first and second embodiments.

FIGS. **38**A–**38**D disclose a fifth embodiment **900** which features an alternative method of designing the rotors. However, the fifth embodiment will also operate on the same principles as the first and second embodiments. The fifth embodiment **900** includes a first rotor **926** made up of a single flywheel **924** mounted on an axis **922** and a second rotor **927** made up of a pair of flywheels **925***a* and **925***b* mounted on axis **923**. Single flywheel **924** has the equivalent mass of both flywheels **925***a* and **925***b* together. The coordinated counter-rotation of the first rotor **926** about the central rotational axis AA—AA is controlled by first and second perimeter transmissions **921***a* and **921***b* driven between first and second track assemblies **918** and **919** respectively. Track assemblies **918** and **919** are separated by supports **916** and handle assemblies **920**. The first and second perimeter transmissions **921***a* and **921***b* are started by a hand crank (not shown). As they rotate in track assemblies **918** and **919**, axle tips **922***a* and **922***b* are frictionally driven within race **930**. As axis **922** is turned, flywheel **924** turns. The first and second perimeter transmissions also cause axis tips **923***a* and **923***b* to be frictionally driven within race **932**. As axes **923** is turned, flywheels **925***a* and **925***b* are also turned. The axis tips **923***a* and **923***b* are canted using a plurality of screws **954** to set the direction of rotation of the axis **923**. Similarly to the first embodiment, the operator grasps the handle assemblies **920** and opposes the net precessional torque created by the rotors **926** and **927** to perform a variable resistance workout.

FIG. **39** discloses a sixth embodiment which is similar to the first embodiment except that it has an alternative hand crank assembly **400**. Crank assembly **400** shows a crank pin **420** that is connected to a bearing **422** which turns a first crank gear **426**. First crank gear **426** interacts with second crank gear **428** which turns third crank gear **432**. Third crank gear **432** turns a fourth crank gear **434** which turns the transmission **86** (not shown) of the first embodiment. Hand crank assembly **400** allows for a lesser degree of force to be used by the operator when starting up the precessional device.

FIGS. **40**A–**40**B disclose a seventh embodiment which features another means of starting the rotation of the rotors of the precessional device **8** of the first embodiment. Whereas the first embodiment uses a hand crank, the seventh embodiment **500** illustrates an electric motor driving the transmission **86** (not shown) of the first embodiment through a plurality of gears. A motor **510** turns a first gear **514** which turns a second gear **518**. In turn, third gear **520** is turned by the second gear **518**. Fourth gear **516** is turned by the third gear **520**. Fourth gear **516** is connected to the transmission **86** of the first embodiment. The use of different sized gears allows for increase in the output torque of the motor **510**. The motor **510**, driven by rechargeable batteries **513** and **514**, is activated when the operator presses a button (not shown). Also, when the user is operating the device, the motor can act as an electric generator by converting a portion of the kinetic energy of the system into electricity to recharge the batteries.

FIG. **41** discloses an eighth embodiment which shows a flywheel **700** with fins **712**. The fins **712** will allow increased air flow in the precessional device **8** to provide cooling and reduce the possibility of damage to the device from being operated at too high a rate.

FIGS. **42**A–**42**B show a ninth embodiment featuring a flywheel **800** which allows its moments of inertia to be adjusted manually. In this embodiment, the flywheel **800** has removable weights **810** mounted on shafts **812** through shaft holes **813** located inside the rim **814** of the flywheel. The flywheel **800** has weights that are removable so that sets of flywheels with different radii or different masses can be used in the same device.

FIGS. **43**A–**43**C disclose a tenth embodiment **1000** which features alternative flywheels **1001***a*–**1001***b* and **1002***a*–**1002***b* that automatically increase their rotational inertia as the rotational velocity increases through an expanding radii. FIG. **43**A discloses axes **1004** and **1006** rotating inside track assemblies (not shown) of the first embodiment. Mounted on axes **1004** and **1006** are the alternative flywheels **10001***a*–**1001***b* and **1002***a*–**1002***b* in a contracted position. FIG. **43**B shows the alternative flywheels **1001***a*–**1001***b* and **1002***a*–**1002***b* in the expanded position. FIG. **43**C shows the components of the alternative flywheel **1001***a*. Surrounding axis **1004** is a spring **1010** which provides a compression force pushing flanges **1011** and **1012** apart. Connected to flange **1011** are pins **1016** and **1020** which connect to portions **1011***a* and **1011***b* of flange **1011**. Similarly connected to flange **1012** are pins **1014** and **1018** which are connected to portions **1012***a* and **1012***b* of flange **1012**. Connecting pins **1014** and **1016** is weighted button **1023** and connecting pins **1018** and **1020** is weighted button **1022**. A starting configuration is shown in FIG. **43**A with the flywheels **1001***a*–**1001***b* and **1002***a*–**1002***b* in their contracted position. As the speed of the spinning axis **1004** picks up, the flywheel **1001** a expands to the fully expanded positions as shown in FIG. **43**B. As the buttons **1022** and **1023** spin faster, they exert a centrifugal force radially outward, which forces flanges **1011**, **1012** together, thereby compressing the spring **1010**. Using flywheel **1001***a* as an example, as the speed of the spinning axis **100** increases further, the flywheel **1001***a* expands to a maximum position and maximum rotational inertia. As the spinning axis **1004** decreases, the flywheel **1001** a will return to its contracted position as shown in FIG. **43**A. The compression dynamics of the spring **1010** can be tailored to effect flywheel **1001** a with the desired dynamic rotational inertia. The tenth embodiment offers the operator an automatic mechanism for adjusting the rotational inertia of the rotors providing at least three benefits: 1) at startup the rotors' rotational inertia is minimized to facilitate startup, 2) at high operational speeds, the rotors' inertia is maximized to increase intensity of the exercise, and 3) the attributes of the compression spring can be tailored to produce the dynamic relationship between speed and inertia that is desired.

FIGS. **44**A–**44**B illustrate an eleventh embodiment which modifies the first embodiment by incorporating a braking mechanism **1060** that stops the rotation of the flywheels **25***a* and **25***b* when the user wishes to discontinue using the device. When the device is lifted off a surface, braking mechanism **1060** will rest on the floor of the lower housing **12**. Extension springs **1062** will act on the braking mechanism **1060** to force prongs **1061** through housing holes **1063**. When the device **8** is placed on the surface, the braking mechanism **1060** will be retracted back into the lower housing **12** and contact the flywheels **25***a* and **25***b*. The flywheels **25***a* and **25***b* will be stopped causing axles **22**, transmission **86**, and axle **23** to also stop.

FIG. **45** illustrates a twelfth embodiment of the precessional device with monitoring equipment **1100**. The monitoring equipment **1100** includes an LCD display **1110** powered by a battery (not shown). The monitoring equipment **1100** is electrically connected through wire **1114** to sensor **1116**. Information displayed may include, for example, current rotations per minute (RPM), time, force and calories burned.

FIG. **46** discloses a thirteenth embodiment which features an alternative method of providing frictional contact between the axle tip **1200** of axis **22** and track race **17**. The axle tip **1200** is coated with a material such as polyurethane, rubber or other synthetic or metallic material.

FIGS. **47**A–**47**B disclose a fourteenth embodiment which features axle tip **1300***a* of axle **22** capped by a beveled gear and a track **1300***b* comprised of a beveled surface that allows for positive rolling contact between the axle tip **1300***a* and track **1300***b* without slippage. The axle tip will travel ideally between two tracks **1300***b* and **1300***c*.

FIG. **48** discloses a fifteenth embodiment **1400** which features handles **1410***a* and **1410***b* that are removable. The handles **1410***a* and **1410***b* may be removed to adjust for different grip positions with different angles and widths to work different muscle groups. Removable or adjustable handles offer the operator a greater range of choices for exercising. By adjusting the handles 90 degrees each as shown, the operator effectively adjusts the device from the first embodiment to the second embodiment or from the second embodiment to the first embodiment. No adjustment of any screws is necessary. Removable handles also facilitates storage and portability.

FIGS. **49**A–**49**B disclose a sixteenth embodiment **1700** featuring pedal attachments **1720***a* and **1720***b* attached to housing **1710** containing the rotors (not shown). The housing **1710** is mounted on a stand **1730**.

The precessional device embodiments herein disclosed are able to produce tremendous forces, limited only by the practical limits to the speed of the rotors, all in a small, lightweight package. This allows the precessional devices to be compact to facilitate storage, portability and use.

As precessional devices, they may be designed to be hand held. This allows the precessional device to be used in a variety of methods, and allows the operator to switch from one method to another quickly and easily.

As precessional devices, they allow the operator to have complete control over the speed, and resulting level of variable resistance, of the exercise.

As precessional devices, the scientific and somewhat complex nature of their operation is an engaging and entertaining activity to witness and master. This makes the exercise activity more enjoyable and effective.

As precessional devices, the intensity of the workout is directly linked to the highly visual and audible stimulus of the rotating and spinning rotors. This direct audio-visual feedback helps to monitor and psychologically reinforce the exercise.

As auto-precessional devices, the rotors' rotation and spin are linked through a simple contact between axle and track that reduces the cost and complexity of the device.

Further applications for the precessional device enclosed herein could include everything from automobile wiper blade motors to industrial brushing motors to the agitator motors found on many consumer and commercial washing machines.

The foregoing is to be understood as being in every respect illustrative and exemplary, but not restrictive, and the scope of the invention disclosed herein is not to be determined from the Detailed Description, but rather from the claims as interpreted according to the full breadth permitted by the law. It is to be understood that the embodiments shown and described herein are only illustrative of the principles of the present invention and that various modifications may be implemented by those skilled in the art without departing from the scope and spirit of the invention.

What is claimed is:

1. An apparatus comprising:

a first rotor spinning about a first spin axis and rotating about a rotational axis inside a first track assembly; and

a second rotor, connected to the first rotor with a transmission spinning about a second spin axis and rotating about the rotational axis inside a second track assembly;

wherein neither of the spin axes are parallel to the rotational axis and wherein both of the track assemblies are substantially continuous about the rotational axis.

2. The apparatus of claim **1**, wherein said first and second rotors rotate in opposite directions.

3. The apparatus of claim **1**, wherein

said first rotor produces precessional torques about first and second orthogonal axes; and

said second rotor produces precessional torques about said first and second orthogonal axes.

4. The apparatus of claim **3**, wherein said precessional torques substantially reinforce each other about the first orthogonal axis.

5. The apparatus of claim **4**, wherein said precessional torques substantially cancel about the second orthogonal axis.

6. The apparatus of claim **1**, wherein

said first rotor produces precessional torques about first and second orthogonal axes;

said second rotor produces precessional torques about said first and second orthogonal axes; and

said precessional torques provide a variable torque about said first and second orthogonal axis.

7. The apparatus of claim **6**, wherein said first and second orthogonal axes and said rotational axis are each orthogonal to the other two axes.

8. The apparatus of claim **1**, further comprising:

a hand crank to start the first and second rotors rotating.

9. The apparatus of claim **8**, wherein said hand crank is connected to a plurality of gears which turn the first and second rotors.

10. The apparatus of claim **1**, further comprising:

an electric motor to start the first and second rotors rotating.

11. The apparatus of claim **1**, further comprising:

first and second flywheels mounted on said first rotor; and

wherein said first and second flywheels include fins.

12. The apparatus of claim **1**, further comprising:

first and second flywheels mounted on said first rotor; and

wherein said first and second flywheels include at least one removable weight.

13. The apparatus of claim **1**, further comprising:

first and second flywheels mounted on said first rotor; and

wherein said first and second flywheels are expandable.

14. An apparatus comprising:

a first rotor spinning about a first spin axis and rotating around a rotational axis;

a second rotor spinning about a second spin axis and rotating around the rotational axis;

first and second flywheels mounted on said first rotor;

third and fourth flywheels mounted on said second rotor; and

a braking mechanism which in a first position is separated from said third and fourth flywheels and in a second position is in contact with said third and fourth flywheels.

15. An apparatus comprising:

a first rotor spinning about a first spin axis and rotating around a rotational axis;

a second rotor spinning about a second spin axis and rotating around the rotational axis;

a first track assembly which supports rotations of said first rotor;

a sensor mounted on said first track assembly; and

monitoring equipment which is electrically connected to said sensor.

16. An apparatus comprising:

a first rotor spinning about a first spin axis and rotating around a rotational axis;

a second rotor spinning about a second spin axis and rotating around the rotational axis;

a first track assembly which supports rotation of said first rotor; and

said first rotor further including first rotor axle tips which spin due to frictional contact with said first track assembly.

17. The apparatus of claim 16, wherein said first rotor axle tips are coated with material from a group consisting of polyurethane, rubber, or a metallic material.

18. The apparatus of claim 16, further comprising:

a first track assembly which supports rotation of said first rotor and includes a beveled surface; and

said first rotor further including first rotor axle tips which are capped by beveled gears and which travel inside said beveled surface of said first track assembly.

19. An apparatus comprising:

a first rotor spinning about a first spin axis and rotating around a rotational axis;

a second rotor spinning about a second spin axis and rotating around the rotational axis;

a plurality of housings; and

at least one handle attached to at least one of said housings said handle being adjustable;

wherein neither of the spin axes are parallel to the rotational axis and wherein both of the track assemblies are substantially continuous about the rotational axis.

20. An apparatus comprising:

a first rotor spinning about a first spin axis and rotating around a rotational axis;

a second rotor spinning about a second spin axis and rotating around the rotational axis; and

a plurality of handles that may be adjusted by 90 degrees.

21. An apparatus comprising:

a first rotor spinning about a first spin axis;

a second rotor spinning about a second spin axis;

said first rotor rotating about a rotational axis inside a first track assembly; and

said second rotor rotating about said rotational axis inside a second track assembly;

wherein neither of the spin axes are parallel to the rotational axis and wherein both of the track assemblies are substantially continuous about the rotational axis.

22. The apparatus of claim 21, wherein said first and second track assemblies are co-planar.

23. The apparatus of claim 21, wherein said first and second track assemblies are located adjacent to each other.

24. The apparatus of claim 21, further comprising:

a first circular gear mounted on said first track assembly; and

a second circular gear mounted on said second track assembly.

25. An apparatus comprising:

a first rotor spinning about a first spin axis, said first rotor including first and second flywheels, and said first rotor rotating about a rotational axis inside a first track assembly; and

a second rotor spinning about a second spin axis, said second rotor including third and fourth flywheels, and said second rotor rotating about a rotational axis inside a second track assembly;

wherein neither of the spin axes are parallel to the rotational axis and wherein both of the track assemblies are substantially continuous about the rotational axis.

26. The apparatus of claim 25, further comprising:

a transmission coupled to said first and second rotors.

27. The apparatus of claim 26, wherein said transmission includes at least one idler gear and at least one drive gear.

28. The apparatus of claim 25, further comprising at least one handle.

29. The apparatus of claim 25, wherein said first spin axis is canted with respect to the first axis.

30. The apparatus of claim 29, wherein said second spin axis is canted off of a second axis.

31. The apparatus of claim 25, wherein said first and second axes are orthogonal to a rotational axis.

32. The apparatus of claim 25, wherein the first and second flywheels are more closely spaced on the first rotor than the third and fourth flywheels on the second rotor.

33. The apparatus of claim 25, wherein the first and second rotors have the same moment of inertia.

34. An apparatus comprising:

a first rotor spinning on a first spin axis;

said first rotor including first and second flywheels;

said first rotor rotating inside a support structure;

a second rotor spinning on a second spin axis, said second rotor including third and fourth flywheels and said second rotor rotating inside said support structure;

a central column located on a rotational axis; and

wherein said first and second rotors rotate in opposite directions about said rotational axis.

35. An apparatus comprising:

a first rotor rotating about a rotational axis in a first track assembly and spinning on a first spin axis;

a second rotor rotating about said rotational axis in a second track assembly and spinning on a second spin axis; and

a transmission operatively connected to said first and second rotors;

wherein neither of the spin axes are parallel to the rotational axis and wherein both of the track assemblies are substantially continuous about the rotational axis.

36. The apparatus of claim 35, wherein said transmission transmits a torque to said first rotor.

37. The apparatus of claim 35, further comprising:

a first yoke supporting said first rotor; and

a second yoke supporting said second rotor.

38. The apparatus of claim 35, wherein

said transmission includes a plurality of gears connected to a central hub; and

said central hub is positioned by a plurality of wire braces.

39. The apparatus of claim 35, wherein

said first rotor includes a spin axle and at least one flywheel; and

wherein said spin axle is preloaded with a canting angle inside a yoke mount assembly.

40. The apparatus of claim 39, wherein

said yoke mount assembly includes a pair of screws; and

wherein said pair of screws cant the spin axle.

41. The apparatus of claim 35, wherein said first rotor includes at least one flywheel and said second rotor includes at least two flywheels.

42. A precessional exercise device comprising:

a first rotor spinning on a first spin axis and a second rotor spinning on a second spin axis;

said first rotor including first and second flywheels;

said second rotor including third and fourth flywheels;

said first and second rotors rotating inside a support structure;

wherein said support structure includes first and second circular tracks;

a central column aligned with a rotational axis; and

wherein said first and second rotors rotate in opposite directions about said rotational axis.

43. An apparatus comprising:

a means for inputting a deflecting torque; and

a means for substantially reinforcing precessional torques about a first axis on a first substantially continuous track assembly and substantially canceling precessional torques about a second axis on a second substantially continuous track assembly.

44. An apparatus comprising:

a first meads on a first substantially continuous track assembly for producing precessional torques about a first axis and a second axis;

a second means on a second substantially continuous track assembly for producing precessional torques about said first axis and said second axis; and

wherein said precessional torques substantially add about said first axis and substantially cancel about said second axis.

45. An apparatus comprising:

a first means on a first substantially continuous track assembly for producing precessional torques about a first axis and a second axis;

a second means on a second substantially continuous track assembly for producing precessional torques about said first axis and a second axis; and

wherein said precessional torques create a variable resistance about said first and second axis.

46. An apparatus comprising:

a first means for producing a plurality of precessional forces acting on a first track assembly;

a second means for producing a plurality of precessional forces acting on a second track assembly;

wherein said first and second track assemblies are connected to form a support structure;

a plurality of handles mounted to the support structure; and

wherein said precessional forces created by said first and second means create a variable resistance at said plurality of handles.

47. A method of using a precessional device comprising a first rotor spinning on a first spin axis and a second rotor spinning on a second spin axis, the method comprising:

inputting a deflecting torque through a plurality of handles to said precessional device; and

pulling and pushing against a variable torque produced by said precessional device along one axis.

48. A method comprising:

rotating a first rotor inside a first track assembly around a rotational axis in a first direction; and

rotating a second rotor inside a track assembly around said rotational axis in a second direction;

wherein said first and second directions are opposite and wherein both of the track assemblies are substantially continuous about said rotational axis.

49. A method comprising:

rotating a first rotor around a first track assembly and about a rotational axis;

rotating a second rotor around a second track assembly attached to said first track assembly and about a rotational axis; and

creating a variable resistance along one dimension;

wherein both of the track assemblies are substantially continuous about said rotational axis.

50. A method comprising:

rotating a first spin axle containing a plurality of flywheels around a first track assembly;

rotating a second spin axle containing a plurality of flywheels around a second track assembly in an opposite direction; and

outputting a variable resistance along a first axis and substantially canceling forces acting along a second axis.

51. A method comprising:

inputting a first deflecting torque to a first rotor rotating in a first direction inside a first track assembly about a rotational axis and a second deflecting torque to a second rotor rotating in a second direction inside a second track assembly about said rotational axis; and

grasping handles attached to a support structure and inputting a third deflecting torque against a variable resistance provided by the first and second rotors;

wherein both of the track assemblies are substantially continuous about said rotational axis.

52. The method of claim **51**, wherein said third deflecting torque causing said first and second rotors to accelerate.

53. The method of claim **52**, wherein said first and second rotors produce precessional torque that substantially reproduce said first and second deflecting torques.

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